

# Shell International Chemicals B.V.

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LONG TERM BEHAVIOUR OF CARILON POLYMER AND COMPETETIVE POLYMERS IN AUTOMOTIVE FLUIDS Part 2: The resistance of CARILON Polymer, PA12 and HDPE to bio-diesel fuel formulations

(March 1996 - April 1997)

by

#### J.J.M.H. WINTRAECKEN AND A. KRAMER





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#### LONG TERM BEHAVIOUR OF CARILON POLYMER AND COMPETETIVE POLYMERS IN AUTOMOTIVE FLUIDS Part 2: The resistance of CARILON Polymer, PA12 and HDPE to bio-diesel formulations

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J.J.M.H. Wintraecken and A. Kramer

Approved by: A. Noordam

#### Summary

To comply with the proposed EURO 2000/2005 legislation aimed at the improvement of air quality, the demands on plastic materials utilised in automotive fuel systems are to be increased substantially. CARILON Polymer shows a natural fit with these demands for future fuel systems which imply: Higher temperature regimes, the use of chemically more aggressive fuels and reduced evaporative emissions of hydrocarbons. To specify CARILON Polymer for fuel system applications the automotive industry not only requires basic mechanical, physical and chemical data but also data on the long term behaviour of this polymer. Especially the long term behaviour data in diesel fuels, including so called 'Bio-diesel', is required.

This report, the second in a series of ageing reports, deals with the long term resistance of CARILON RDP 205 at 80 °C, the competitive Polyamide 12 (PA12) at 80 °C and the competitive high density polyethylene (HDPE) at 60 °C to Bio-diesel fuels: Rapeseed methyl ester (RME) and diesel/RME (85/15 v/v) mixture.

At 60 °C, the envisaged continuous operation temperature of the fuel tank, CARILON Polymer RDP205 exhibits compared with HDPE an excellent retention of properties in RME. CARILON Polymer RDP 205 outperforms HDPE in dimensional stability, stiffness, snappability characteristics (yield performance) and ultimate stress and strain. At 80°C the continuous service temperature level at the sender unit, CARILON Polymer RDP 205 exhibits compared with PA12 a very good retention of properties in diesel/RME and RME. CARILON Polymer RDP 205 outperforms PA 12 in dimensional stability, stiffness and snappability characteristics. At 80 °C the long term ultimate strain behaviour of CARILON Polymer RDP205 in diesel/RME (85/15) v/v is acceptable, but improvement is needed if performance above 80 °C will be required.

The excellent ageing properties of CARILON Polymer in RME and diesel/RME (85/15 v/v) at 60 °C and 80°C also confirm the natural fit of CARILON Polymer in diesel fuel systems.

January, 1998

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## LONG TERM BEHAVIOUR OF CARILON POLYMER AND COMPETITIVE POLYMERS IN AUTOMOTIVE FLUIDS

#### 1. Introduction

Long term performance data on CARILON Polymer are needed to support our customers in the automotive industry in their decision making process on material specifications for fuel system parts. At SRTCA a long term ageing program of CARILON Polymer and competitive materials in automotive fluids is being carried out. The 'CARILON ageing program' comprises:

- 1) The resistance of CARILON Polymer and HDPE to standard diesel fuel (See: CA.97.20523),
- The resistance of CARILON Polymer, HDPE and PA12 to RME and diesel/RME fuel (subject of this report),
- 3) The resistance of CARILON Polymer and HDPE to EOLYS catalytic oxidation converter for diesel fuel (The next report in this series).

#### 1.1 The resistance of CARILON Polymer, HDPE and PA12 to RME and diesel/RME

As explained in the first report<sup>1</sup> not only the temperature regime in the fuel system of compression ignition engines (diesel engines) increases, also the aggressiveness of the modern and future diesel fuels increases. One category of these modern fuels is the so called bio-diesel fuel<sup>2</sup>. Characteristic for bio-diesel fuels is that they contain component(s) of vegetable crops.

In general bio-diesels can comprise the following constituents:

1) vegetable oils or blends of oils,

2) methyl esters of vegetable oils and blend thereof, and

3) blends of vegetable oils or methyl esters with conventional (crude oil based) diesel fuel.

For this study we have selected rape seed methyl ester (RME) and a blend of diesel/RME (85/15 v/v). Such type of fuels are currently used, amongst others in France and Germany and are known to be aggressive to some polymers.

The polymeric materials selected for this standard diesel ageing program are:

- 1. CARILON Polymer RDP 205 (New name: D26HM100)
- 2. HDPE Lupolen 5021D Q425 ex BASF and
- 3. PA12 Rilsan A AMNOTLD ex ELF.

HDPE was selected because this material is the current standard material used for the manufacture of blow-moulded fuel tanks for passenger cars. PA12 represents one of the polyamide polymer types used for the manufacture of fuel lines, an other attractive market segment of the fuel system in which CARILON Polymer offers potential.

The primary ageing medium selected is RME, supplied by Novaol (France). In the blend standard diesel fuel CEC-RF-90-A-92 was used<sup>2</sup> at a diesel/RME ratio of 85/15 v/v, which is used in France. As a reference medium air was included in the program. This was included in order to be able to compare the results obtained in this program with data obtained in earlier programs<sup>3</sup>.

In RME and diesel/RME the ageing temperatures selected were: 60 and 80 °C:

- 60 °C was selected for HDPE as this temperature is the envisaged maximum operation temperature limit for HDPE diesel fuel tanks. (Earlier work<sup>1</sup> has shown that in diesel above 60 °C the modulus of HDPE decreases to < 50% of its initial value within 100 hours)</li>
- 80 °C was selected for CARILON Polymer and PA12. 80 °C is the envisaged continuous service temperature for fuel lines and sender units of fuel systems of modern direct injection diesel engines.

In air the selected ageing temperatures are 23 °C, 60 °C and 80°C.

- 23 °C was selected as a reference temperature. It simulates the idle time of an empty fuel system. These data allow a quantification of the physical ageing behaviour of the polymers in this test series.
- 60 °C was selected for testing HDPE, and
- 80 °C was selected for testing CARILON Polymer and PA12, giving additional data to the results of the first report<sup>1</sup> of this series.

Test intervals selected initially were: 0, 100, 500, 1000, 2000, 3000 hours. In discussions with the automobile industry on the long term ageing in fuels of CARILON Polymer, it appeared that ageing data up to 5000 hours ageing were required. Therefore we have extended for the CARILON Polymer series and the HDPE series the ageing time from 3000 h to 5000 h by carrying out an additional ageing program. The results of that additional program are included in this report. For PA12 this was not possible as no test specimens of that material were left.

The testing conditions selected for this program are in agreement with ISO 175. Test conditions for determination of the properties: 23 °C  $\pm$  2 °C and 50 %  $\pm$  10 RH. To avoid confusion the terms test temperature and ageing temperature will be used throughout this report.

#### 2. Experimental

The details on the materials, specimen manufacture and conditioning, ageing media, test conditions and monitoring tests are given in the following sections and are summarised in the Appendices 2 A to C, 3 A and B and 4 A to D.

#### 2.1 Polymer materials used

The polymers selected for this study are given in the table below:

Table 1. Polymers tested.

Nr	Polymer	Identification	Supplier	Batch/lot number	Date Injection Mouldin
1	PK	CARILON Polymer RDP 20	Shell Chemicals	05WMA062	05-07-96
2	PA12	Rilsan A AMNOTLD	ELF	Lot 311337	08-02-96
3	HDPE	Lupolen 5021D Q425	BASF	Lot 463-309043	05-07-96

#### 2.2 Injection moulding

Before injection moulding the CARILON Polymer, PA12 and the HDPE were dried in special gauze trays in a vacuum oven at the following conditions: 400 mbar, 60 °C and 16 hours. Specimens were then moulded using a Battenfeld BA 250/050 with UNILOG 4000 A2 system injection moulding machine. A multi-cavity mould with a turn-key gating system set at the tensile specimen cavity, in accordance with ISO527, has been used. The moulding details of these three series of specimens are given in Appendix 1.

#### 2.3 Specimen identification and conditioning

All specimens have been coded according to the overviews given in the Appendix 2 and Appendix 4 using an engraving device. Thereafter the specimens were conditioned for at least 3 days at 23 °C and 50 % RH.

#### 2.4 Ageing media and ageing conditions

The media used in this study are given in the table below:

Table 2 Media used for the ageing tests.

Nr	Medium	Identification	Supplier	Batch/Lot number
1	Diesel	RF-90-A-92	Haltermann	Batch 6
2	RME	RME Lims ref. 95-05708	Novaol	Batch 5248
3	Air			

The conditions of the ageing tests are carried out in accordance with ISO 172 and are summarised in Appendices 2 to 4. At regular intervals during the ageing period the cylinders with the ageing specimens were stirred, but contrary to ISO 172 the ageing media were not refreshed during the ageing testing.

#### Testing conditions:

In RME and diesel/RME 85/15 %v the ageing temperature is: 80 °C for CARILON RDP 205 and PA12. HDPE is tested in RME only at 60 °C. In air the selected ageing temperatures are 23 °C for all polymers, 60 °C for HDPE and 80°C for CARILON RDP 205 and PA12. Test intervals of all series can be found in the Appendices 2 to 4.

Specimens aged in RME and diesel/RME were placed in racks ensuring that these specimens were standing vertically and free from each other in stainless steel cylinders. Immediately before the start of the ageing the cylinders containing the specimens were filled with RME or diesel/RME such that the specimens were fully submerged. Then the cylinders were closed and placed in air circulating ovens set at the required ageing temperature. A drawing of the racks and the cylinders is added in Appendix 5.

At each ageing period the required cylinders were withdrawn from the ovens and allowed to cool for 15 to 30 minutes. Then the cylinders were opened carefully and the racks with the specimens lifted from the cylinders. Each specimen was then rinsed 5 to 10 seconds in a 100 ml glass cylinder filled with toluene (99 %) at room temperature, followed by carefull drying with a soft clean cloth. Thereafter these specimens were tested.

Specimens aged in air were placed horizontally in the oven, free from each other, on an open wire rack. After each ageing period the required specimens were taken from the rack. No further treatment was given before the testing. To avoid any cross-contamination each polymer series was aged in a separate oven.

#### 2.5 Monitoring tests

The monitoring tests are given below:

#### 2.5.1 Tensile test

The tensile tests were performed on an Instron 4507 tensiometer according to ISO 527. At least 5 specimens were tested, the tests were carried out at 23 °C  $\pm$  1 °C and a relative humidity between 40 and 60%. The machine parameters are given in Table 3:

Table 3. Tensile test parameters

Parameters	
Grip distance (mm)	115
Extensometer	Long travel type, 0 to 500 % extension
Grip length (mm)	50
Crosshead speed (mm/min)	100

The following tensile properties were calculated: secant modulus, yield stress, yield strain, stress at break and strain at break. As the available data acquisition system allows only a limited number of data points, the calculation of Youngs modulus is not possible. However reproducible data on the stiffness of the materials can be obtained using the secant modulus calculated between 0 and 2 % strain.

#### 2.5.2 Mass and dimensions

For the mass change and dimensional change a separate series of specimens were aged and treated under conditions given in section 2.4, however these specimens were replaced after testing. Before the ageing started the specimens were conditioned for minimum 3 days at 23 °C and 50 % RH. At each test period the specimens were taken from the ovens or cylinders and directly after cooling to 23 °C the mass and the dimensions determined. The mass change is calculated as a percentage of the mass change relative tot the initial mass. The dimensional change is calculated as a percentage of the dimensional change relative tot the initial dimension.

#### 2.5.3 Yellowness index

To monitor change in colour the DIN 6167 standard has been selected. The measurement was carried out on a Data Color 3890 using the manufacturer's standard supplied software for the calculation of the yellowness index. The measurements were carried out on at least five tensile specimens immediately before they were tested for their mechanical properties.

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#### 3. Results and discussion

All results summarised in the Tables 4 to 9 and all basic data are available in SRTCA CTCAR/2 laboratory book PRP/832/95, appendix 50. The graphical presentation of the results is given in the figures 1 to 24 in the sections 3.1 and 3.2. Data points in the figures are connected with lines for no other purpose than guiding the eye.

First we will discuss the changes in mass and dimensions followed by the changes in tensile behaviour and yellowness. Each of these aspects will be discussed for CARILON RDP 205, PA12 and HDPE. Finally a comparison of the all polymers with respect to ageing is given.

#### 3.1 Effect of ageing on the mass and dimensions of CARILON RDP 205, PA12 and HDPE

All results of the measurements of ageing on the mass and dimensions of CARILON RDP 205, PA12 and HDPE in the Tables 5, 7 and 9.

The changes in mass for CARILON RDP 205 are given in Figure 1. The results show that after 3000 hours a plateau is reached and the changes in mass in diesel/RME are very small (+0.3%), in RME the changes are even smaller and vary between -0.2% and -0.1%.

In air at 23 °C and 50 % RH a plateau in mass increase of 0.5 % is found after 1000 hours. This indicates that the 3 days conditioning before the start of the ageing tests was insufficient to reach an equilibrium. At 80 °C in air a mass change plateau of -0.6 % is found, thus the total volatile matter in the CARILON RDP 205 samples after a long period of conditioning (>3000h) is in the order of 1.1 %. This has not been observed before, a value of 0.6 % to 0.7 % would be more in line with earlier moisture absorption measurements<sup>4</sup>. However these earlier measurements were carried out over a shorter period and at different temperatures.



For PA12 the mass change in diesel/RME 85/15 is substantial: after 3000 hours a 1.8% mass increase is observed, for RME a 1.2% mass increase is observed after that period. It is important to realise that at that ageing period the mass change is not yet stabilised, an increasing trend is observed. Thus the further flexibilising effect of the Diesel and RME on the PA12 should be expected.

In air at 23 °C the mass increase after 3000 hours is about 0.6 %, and an increasing trend is noticed at this point in time. Thus the moisture pick-up, a well known phenomenon of polyamides, is not yet stabilised after 3000 hours at 23 °C and 50 % RH.



At 80 °C in air the mass change is -0.3 % after 3000 hours indicating a loss of moisture.

For HDPE the mass change at 60 °C in RME is very high: 5.5 %. This plateau value is reached after 100 hours exposure to the RME. Therefore a high level of flexibilisation is to be expected for HDPE after 100h at 60°C.

In air at 23 °C and 50 % RH and at 60 °C the mass changes are negligible over the ageing period of 3000 hours.





Figure 4. Effect of RME and RME/diesel on CARILON Polymer RDP205, Dimensions, Width Change at 23 °C

Time, h

The dimensional changes are determined at the width of the specimens and the results are given in the figures 4,5 and 6.

For CARILON Polymer RDP 205 (Figure 4) the changes in width aged at 80 °C in diesel/RME are small; a plateau value of 0.2% is detected after 500 hours. In RME the change is < 0.1%. In air 23 °C and 50 % RH the change in width is after 500 hours at a plateau value of 0.2 % in air at 80 °C the dimensional changes are very small, < 0.1%.



Figure 5. Effect of RME and Diesel/RME 15% on PA12,

For PA 12 the changes in width (dimensions) in diesel/RME and RME show the same trends as the changes in mass, indicating the absorption of these two types of diesel engine fuels. The width change is in diesel/RME aged at 80 °C shows a maximum value after 2000 hours at about 0.8 %, in RME at 80 °C the width change show at 2000 hour also a maximum of about 0.5%.

In both cases the width change shows a decrease, this is unexpected as the mass change still shows an increase after 2000 hours ageing. It is also clear that the dimensional changes for PA 12 are clearly higher than for RDP205. Aged in air at 23 °C and 50 % RH the width change shows a gradual increase to about 0.3% after 3000 hours. Aged in air at 80 °C the change in dimensions over 3000 hours is negligible.



The change in dimensions of HDPE in RME at 60 °C are as expected high, a plateau value of width change of about 1% is found. The plateau value is reached rapidly: within 100 hours. In air at 23 °C and 50% RH and at 60 °C the changes are negligible.

#### 3.2 Effect of ageing on the tensile properties of CARILON RDP 205, PA12 and HDPE

In this part the ageing effect of diesel/RME and RME on the tensile behaviour and the changes in yellowness of RDP 205, PA12 and HDPE will be discussed. The set-up of this part of the work is given in the Appendix 3, the coding, and arrangement of the specimens in Appendix 4 and the measured data in the Tables 4 to 9.

The changes in secant modulus over the ageing period for CARILON RDP 205 are given in Figure 7. Aged at 80 °C in diesel/RME 85/15 and RME 100% the change is very small, the level of the secant modulus is respectively 1200 and 1400 MPa. This plateau value is reached after 500 hours. In air at 23 °C and 50 % RH first a decrease is observed untill 1000 hours, thereafter up to 3000 hours an increase, indicative for a physical ageing effect. For ageing in air at 80 °C the secant modulus of CARILON RDP 205 first shows a steep increase up to 1500 MPA in the first 500 hours, then the modulus shows a very slow increase. This phase of very slow increase may be caused by a very slow crosslinking reaction<sup>5</sup>.

The change in secant modulus of PA12 (Figure 8) is the same in diesel/RME and RME, in both cases a decrease is found after each period of testing, the changes are the highest in the beginning. The loss in modulus is about 25 %. It is caused by the plasticising effect of the diesel/RME or RME. The change in secant modulus of PA 12 aged in air at 23 °C also shows a decreasing trend, in this case the absorbed moisture causes the plasticising effect observed. Aged at 80 °C the secant modulus of PA12 first shows a steep increase to about 1400 MPA in the first 500 hours, then the modulus shows a very slow increase.



Figure 7. Effect of RME and RME/diesel on CARILON Polymer RDP205, Secant modulus at 23 °C

The change of secant modulus of HDPE on ageing in RME (Figure 9) shows a severe decrease in the first 100 hours from about 800 to 500 MPa, at about 500MPa a plateau is reached. Again the explanation is the plasicising effect of the RME. The changes on ageing in air are negligible.



The effect of ageing on the yield stress of CARILON RDP 205 is shown in Figure 10. Ageing in diesel/RME and RME gives comparable results, initially up to 500 hours an increase, thereafter a plateau at a level of agout 70 MPa. In air at 23 °C no changes are observed. In air at 80 °C the results are comparable to diesel/RME but at a slightly higher level.





The effect of ageing on the yield stress of PA12 is shown in figure 11. In diesel/RME and RME at 80 °C P12 shows in 3000 hours no change of the yield stress, in air at 23 °C a slight loss is observed. In air at 80 °C the yield stress increases in the first 500 hours from 40 to 45, than a plateau value is reached.



No or only a marginal change in yield stress is found for HDPE aged in RME at 60 °C, aged in air at 23 °C 50% RH and air at 60 °C (Figure 12).



Figure 12. Effect of RME on HDPE, Yield Stress at 23 °C

The yield strain of CARILON Polymer RDP 205 aged at 80 °C in diesel/RME and RME decreases in the first 500 hours from 22 % to 18%, then a slight increasing gradient is observed. In air at 23 °C and 50 % RH a very gradual decrease is observed over the 3000 hours test period: form 22 % to about 19 %. In air at 80 °C the yield strain change is comparable to that of the diesel/RME and RME.



Figure 13. Effect of RME and RME/diesel on CARILON Polymer RDP205 Yield Strain at 23 °C

The change of the yield strain of PA12 differs clearly form CARILON RDP 205. Aged at 80 °C in diesel/RME and RME the yield strain increases from initially 11 % to 16 % after 3000 hours. Nevertheless this value is still below the yield strain of CARILON RDP 205. The yield strain in air at 23 °C 50 % RH and in air at 80 °C is more or less unchanged over the 3000 hours of test.



The yield strain of HDPE aged in RME at 60 °C changes in the first 100 hours from 12% to 25 %, thereafter a plateau is reached at 25 %. This can be explained by the plasticising effect of the RME. No change is observed for the ageing results in air at 23 °C 50% RH and in air at 80 °C.



The stress at break data of CARILON RDP 205 (see figure 16) show a clear decrease in the first 500 hours from 64 to about 50 MPa, thereafter a plateau value is reached for diesel/RME, RME and air at 80 °C. No changes are observed are observed in air at 23 °C 50 % RH.



Virtual no change of stress at break of PA12 has been found for diesel/RME, RME and air at 23 °C and the level is about 55 MPa (Figure 17). In air at 80 °C a substantial decrease is found in the first 1000 hours of ageing: from 55 MPa to 38 MPa, thereafter a plateau is observed.



Figure 17. Effect of RME and Diesel/RME 15% on PA12,

Ageing in air at 23 °C 50 % RH, air at 60 °C and RME at 60 °C has no effect on the break stress of HDPE (Figure 18).



Figure 18. Effect of RME on HDPE, Break stress at 23 °C

The effect of ageing on the strain at break of CARILON RDP 205 is given in the Figure 19. The results show that ageing at 80 °C in diesel/RME, RME and air have a drastic effect on the strain at break, a loss from about 350 % to about 175 % is found in the first 500 hours. Thereafter a trend of gradual decrease of the strain at break is observed. After 300 hours a strain at break level of about 150 % is found. Also it should realised that the scatter of the results of the strain at break is always higher than for properties like the modulus or the yield stress and strain (see Table 4).



Figure 19. Effect of RME and RME/diesel on CARILON Polymer RDP205, Strain at Break at 23 °C

For PA 12 effect of ageing in diesel/RME and RME at 80 °C on the strain at break (Figure 20) is small, the value changes from about 380% to 340%, and most of that change is in the first 500 hours. Ageing in air at 23 °C 50 % RH has no or only a marginal effect on the strain at break. Ageing in air at 80 °C does result in a decrease of the strain at break from about 380 % to about 320 %.



For HDPE the effect of ageing in RME at 60 °C (Figure 21) on the strain at break is rather small if we take in account that HDPE shows a substantial increase in mass over the ageing period. The strain at break increases from about 70 % to about 95%. In air a comparable trend in the change of the strain at break is found.



The effect of ageing on the yellowness of CARILON RDP 205 is shown in Figure 22. The yellowness changes in diesel/RME, RME and air are comparable, a steady increase form 4 to about 40 is found. In air at 23 °C 50 % RH no change is found.



Figure 22. Effect of RME and RME/diesel on CARILON Polymer RDP205, Yellowness Index DIN 6167, 23 °C

The changes in yellowness due to ageing of PA 12 are given in Figure 23. The changes in diesel/RME and RME are comparable, a fast change in the first 500 hours and thereafter a slow increasing or stabilising trend. The yellowness changes from -30 to 80, which is higher than for CARILON RDP 205. In air at 80 °C the change in yellowness is lower, from -30 to 30. The yellowness does not change when aged in air at 23 °C 50 % RH.



Figure 23. Effect of RME and Diesel/RME 15% on PA12, Yellowness Index at 23 °C

The effect of ageing on the yellowness of HDPE (Figure 24) in RME at 60 °C is very small and negligible in air.





## 3.3 Comparison of ageing behaviour of CARILON RDP 205, PA 12 and HDPE

Comparing the dimensional changes after ageing of CARILON RDP205, PA12 and HDPE in RME (100%) it is clear that CARILON RDP 205 performs substantially better: after 3000 hours the dimensional change of PA 12 is about 4 times higher than CARILON RDP 205, the dimensional changes of HDPE is about 10 times higher than CARILON RDP 205. The dimensional changes in diesel/RME are of the same order but only tested for PA12. In air the dimensional changes at the ageing temperatures 80 °C or 60 °C are negligible for all three polymers, at 23 °C and 50 % RH the dimensional stability differs slightly, PA shows as expected the highest change, HDPE the lowest change.

For CARILON RDP 205 aged 3000 hours in RME at 80 °C a change in mass of -0.1% corresponds with a change in dimensions of 0.1%, aged in diesel/RME at 80 °C a change in mass of 0.4% corresponds with a change in dimensions of 0.2%. For PA12 aged 3000 hours in RME at 80 °C a change in mass of 1.2% corresponds with a change in dimensions of 0.4%, aged in diesel/RME at 80 °C a change in mass of 1.7% corresponds with a change in dimensions of 0.7%. From this follows that the diesel fuel has more effect in the mass and dimensional changes than the RME.

Comparing the tensile secant moduli at 23 °C, of the three polymers CARILON Polymer RDP 205 performs best, in all cases it shows the highest secant modulus. If we compare the <u>initial</u> secant moduli of the other polymers tested with CARILON RDP 205, PA12 shows a retention of 95%, HDPE a retention of 60 %. After 3000 hours ageing in diesel/RME or RME, PA12 shows a retention of 70 %, HDPR a retention of 40 %. Thus ageing in diesel/RME or RME is much more aggressive for PA12 and for HDPE than for CARILON RDP205. The advantage in stiffness of CARILON RDP 205 can be exploited in design of components where at equal stiffness a CARILON component requires a lower thickness and thus lower mass.

CARILON RDP 205 maintains after 3000 hours ageing at 80°C in diesel/RME and RME a substantially higher yield stress and strain than PA12 and HDPE. Thus under the conditions of test snapfit joints of CARILON RDP 205 will perform much better than those of PA12 or of HDPE.

The ultimate stress of CARILON RDP 205 and PA12 after ageing 3000 hours in diesel/RME and RME at 80 °C are comparable, however the ultimate strain of PA12 is clearly better. Under these conditions the ultimate strain retention of CARILOM RDP 205 is 53 %, the ultimate strain retention of PA 12 is 88% and the ultimate strain retention of HDPE, after ageing 3000 hours in RME only, at 60 °C, is 117 %. In air at elevated temperatures the retention of the ultimate strain after ageing for CARILON RDP 205 is 45%, for PA12 it is 80%. Moreover the initial ultimate strain is for PA12 400% and for CARILON RDP 205 350 %. This lower retention of ultimate strain is obviously a weakness of CARILON Polymer RDP205 which has been observed in the first part of this program and in earlier programs on the thermal and oxidative stability. Although the minimum retention levels required by our customers are not known it can be expected that the industry will require retention levels of 50 % or above over the full lifetime of a component. Therefor this aspect needs further attention.

As far as the yellowing is concerned HDPE performs substantially better than CARILON RDP 205 and PA12. This observation shows that a dark yellow or brown surface colour of neat fuel system components is not necessarily an indication of loss of performance or degradation of such a component. Moreover this is a strong argument for using black coloured CARILON in this application field.

#### 4. Conclusions

- At 60 °C, the envisaged continuous operation temperature of the fuel tank, CARILON Polymer RDP205 exhibits compared to HDPE an excellent retention of properties in RME. CARILON Polymer RDP 205 outperforms HDPE in dimensional stability, stiffness and snappability characteristics and ultimate stress and strain.
- At 80°C the envisaged service temperature level of fuel lines and sender units, CARILON Polymer RDP 205 exhibits compared to PA12 a very good retention of properties in diesel/RME and RME. CARILON Polymer RDP 205 outperforms PA 12 in dimensional stability, stiffness and snappability characteristics.
- At 80 °C the long term ultimate strain behaviour of CARILON Polymer RDP205 in diesel/RME 85/15 v/v is considered acceptable (confirmed by recent customer feedback), PA12 shows in this respect a better performance. Improvement of the long term ultimate strain behaviour of CARILON Polymer RDP205 in diesel/RME 85/15 v/v is needed if performance above 80 °C will be required.

#### 5. Recommendations and further work

Based on the conclusions above it is recommended to further exploit the excellent performance of CARILON Polymer in modern diesel fuel system applications where diesel/RME and RME are used. CARILON Polymer clearly shows a natural fit in the material palette available to the automotive industry for diesel fuel systems.

Further work and some proposals to further work:

- The execution and reporting of the next part of the CARILON ageing program: the resistance of CARILON Polymer and selected other polymers to EOLYS oxidation catalysts.
- The execution and reporting of the 'CARILON competitive positioning program'.
- Based on the outcome of this study further work will be required to understand the high scatter of the strain at break of CARILON Polymer after ageing in diesel and air. A study of fracture surfaces needs to be a part is this investigation.
- The effect of peak temperatures above 100 °C need to be addressed in a further study.
- The effect of ageing on impact behaviour needs to be addressed.
- Finally to mimic the real live situation of a fuel tank on a car also ageing tests using (small) tanks should be carried out on selected polymeric materials.

Amsterdam, January 1998

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## Table 4. Influence of diesel/RME and RME on CARION RDP 205

		100000000000000000000000000000000000000	10000000000000000000000000000000000000	0000077.00000.00000000	100000000000000000000000000000000000000	00000 Y 900 20 100000000	000000 7 00100 000000000	000000000000000000000000000000000000000	000000000000000000000000000000000000000	898889°T P8753755788888888
time	Modulus	Modulus	Modulus	Modulus	Modulus	Modulus	Modulus	Modulus	Modulus	Modulus
(0)	(MPO)	SDIMPO.		SD (MGA)		SDIMRO III	(MEC)	SO(MED)	(MPA)	SU (MPA)
	23°C/air	23°C/ai	BUTC/BI	BUTCHAIL	BUISHME	BUTISHME	BUTOURME	BUILUHME	2010UHME	23 UUHME
U	1312	60	1312	60	1312	60	1312	00	1012	00
261	1252	34	1500		1000	49	1442	10		
480	1263	68	1530	70	1300	40	1442	10		
804	1210	<u>81</u>	1017	22	1247	20	1403	35		
2050	1300		1661	23	1047	20	1503	50	1637	
	1309	50	1600	53	1310	105	1330	52	1007	
0000525530000	1407	50	1609	36	1010	64	1335	52		
	1471	37	1643	30	1100	56	1412	56		
	14/1		1045		1150		1412			
1001017704440181818	Hilled Sol. In Mer. and whether	SHEAL be in the second datable	838864-34.9-394.3-3950488888	SBB4cbab/SharrontorSSS	Relibio, faular Alara accounce de la	88886 Pri	and the set of the second second second	BEER Hele Bernederbelligt	MININ MT PT IP IP IP IP	BEEFF P. P. STAPPENIN
UIK .	SEVIELE SUESSIE	BRANCE RELIESE		BRATE DESCRIPTION						
		HISTANCE IN	(IVE 6)							
			21.1	0.22	21 1	0.22	61.1	0.22	61 1	0.22
100	59.60	0.22	01.1	0.22	01.1	0.22	01.1	V.22	01.1	0.22
192	50.09	0.29	72 67	0.82	69.03	6.24	80.86	03		
400	50.75	0.13	72.60	0.02	87.87	0.18	69.74	0.0		
DOCO.	61 31	1 32	74.07	0.16	68.75	0.10	71.06	0.29		
0076	50.40	0.28	74.02	0.26	00.75		71.5	1.08	62.82	
2006	61 16	0.84	74.99	0.15	67.53	1.39	68.57	1.22	02.05	
anne	59.75	0.19	74.39	0.18	67.34	1.09	69.05	0.17		
5016	60.72	0.14	75.86	0.28	67.93	0.11	70.27	0.25		
	00.72	0.14	73.00	0.20	07.00	0.11	70.21	0.20		
	BBR PG 75 BPG PPG PGB	8889000010979919888	Rilling boood alotte	1888919191999999999988	1000097975 B25929 P2888	188845555799799199888	International Second Second	88887757525777779888	BREW POPPORTON POPPORT	10000000000000000000000000000000000000
UNC		88885777248888	REPORT OF A VERY AND A				CALCULATION OF A	RESERVED AND	10/10/0/	STIM
<u>in in i</u>	022664		R/PC/air		ANISCHIE	RAVISENE	BOLLOOBAE	BOVIDOBME	23/100846	23/100BME
0	20 6741	0.78	22.40	0.78	22 49	0.78	22.49	0.78	22.49	
100	22.49	1.24	22.40	0.70	22.40	0.70	22.75	0.70	22.40	
132	22.55	1.04	17 16	0.96	17.46	0.49	17.95	0.77		
964	22.10	2.50	16.85	1 28	18.57	1 16	17.00	0.61		
2955	20.24	1.08	16.50	0.34	18 59	0.35	17.81	0.47		
2000	20.24	0.73	15 74	0.46	10.00	0.00	17.14	0.29	18.35	
anoe	10.01	0.35	16.53	0.43	18 58	0.76	18.76	0.39	10.00	
1000	20.25	0.53	16.43	0.00	19.08	0.66	18.29	0.8		
	19.78	0.48	16.28	0.44	19.14	0.47	17.58	0.41		
19999999999999999999999	10.10	0.10								
time	Stress break	STOS DIGAS	In the second second	ISTOSS DOGR	stress break	STOSS DIGAR	Stress break	stress break	stress break	stress break
(h)	(MPa)	SD (MPa)	(MPa)	SD (MPa)	(MPa)	SD (MPa)	(MPa)	SD (MPa)	(MPa)	SD (MPa)
	23°C/air	23°C/air	80°C/air	80°C/air	80/15FME	BO/15RME	BO/100PIME	BO/100RME	23/100RME	23/100RME
0	64.62	11.05	64.62	11.05	64.62	11.05	64.62	11.05	64.62	11.05
192	69.3	5.49								
480	60.67	11.55	50.91	0.93	50.14	0.56	50.59	0.61		
864	64.18	9.99	50.33	1.7	50.63	0.62	50.87	0.69		
2856	62.83	12.55	54.42	9.57	49.64	1.92	49.19	1.87		
2976	58.77	8.92	49.49	2.14			50.78	1.13	57.4	
3096	58.54	12.32	49.72	1.42	49.39	1.56	49.08	2.37		
4008	59.97	112.11	49.56	1.19	46.86	1.66	50.18	8.92		
5016	61.91	11.65	48.72	2.9	47.32	2.58	49.82	0.56		
time	strain break	strain break	strain break	strain break	strain break	strain break	strain break	strain break	strain break	strain break
(h)	(%)	SD (%)	(%)	SD (%)	(%)	SD (%)	(%)	SD (%)	(%)	SD (%)
	23°C/air	23°C/air	80°C/air	80°C/air	80/15RME	80/15RME	80/100RME	80/100RME	23/100RME	23/100RME
Q	350.2	13.08	350.2	13.08	350.2	13.08	350.2	13.08	350.2	13.08
192	367	5.6								
480	356.6	9.5	166.61	53.86	145.2	56.22	187.8	80.53		
864	358.3	7.8	154.1	40.2	234.3	83.2	246.9	105.2		
2856	357.42	9.65	175.17	101.04	217.11	66.49	181.61	116		
2976	337.8	18.37	71.79	34.61			125.12	72.88	357.7	
3096	3/01	7.86	156.22	82.81	193.61	103.96	179.8	103.36		
	0-10.1	7.00	100.22	02.0	100.01	105.60	170.0	100.00		
4008	311.22	35.78	112.49	50.26	160.06	84.6	124.04	91.42		

# Table 5. Influence of diesel/RME and RME on CARION RDP 205

		Y IIII	YI.	YI	Y.I.					
h	29°C/air	80°C/air	80/15RME	BOTIOORME	23/100FME					
0	3.5	3.5	3.5	3.5	3.5					
192										
480	3.044	11.38	11.89	7.108						
364	2.797	10.70	20.43	12 42						
2050	4.312	35.838	20.40	10.711	10.17					
3096	3.494	34.711	24.23	37.967						
4008	4.627	40.543	29.754	39.116						
5016	5.152	46.817	35.063	40.82						
000000000000000000000000000000000000000	183803020083888888	866666443465666666666	1000.054543445000000000000000000000000000	88.649.8777979988	18797277787299988	BLLL B. Briteric Statements Still	BLALD. Buigeboord	<u>88445</u> สร.ใหญ่ชองใหญ่ทุกษณ์ไป	M. L.	Bizzza Beneralisteria III
1(1)9	BILL AND SEE								101040102010100000000000000000000000000	
10	2997./6/	BO*C/air	ROCARMETER		230/100805	23 6/41	B(t*C/eir	BOOZEME1554	BOC/100PME	230/100BME
0	62,470	62.470	62.470	62.470	62.470	62.470	62.470	62.470	62.470	62.470
192	62.470	62.470	62.470	62.470	62.470	62.696				
480	62.470	62.470	62.470	62.470	62.470	62.6778		62.5083	62.3897	
864	62.470	62.470	62.470	62.470	62.470	62.7593	62.0881	62.5012	62.3372	
2856	62.470	62.470	62.470	62.470	62.470		62.072	62.737	62.444	
2976	62.470				63.2391	62.7954	62.102		62.451	63.514
4152					63.298					63.3929
3096	62.996	63.045	62.944	63.139		63.044	62.645	63.21	63.094	
4008	63.062	62.914	63.173	63.182		63.104	62.493	63.385	63.115	
5016	63.290	63.078	63.249	63.176		03.327	02.00	03.405	63.107	L
A MARK		I THE A PROPERTY OF	IN MARCHART	IN LOSS GRAMM	Mass cain					
(h)	(%mass)	(%mess)	(%mass)	(%mass)	(%mass)					
<u></u>	23°C/air	80°C/air	80G/PME15%	BOC/100RME	23C/100RME					
0	0.000	0.000	0.000	0.000	0.000					
192	0.362									
480	0.333		0.061	-0.129						
864	0.463	-0.611	0.050	-0.213						
2856		-0.637	0.427	-0.042	0.425					
2976				·	0.455					
	0.576	-0.634	0.423	-0.071	0.130					
4008	0.570	-0.669	0.336	-0.106						
5016	0.558	-0.679	0.342	-0.109						
						•				
time	Width	Width	Width	Width	Width	Width Gain	Width Gain	Width Gain	Width Gain	Width Gain
(h)	(mm)	(mm)	(mm)	(mm)	(mm)	(%)	(%)	(%)	(%)	(%)
A	23"G/air	0,901	0 801	9,801	9.801	0.00	0.00	0.00	0.00	0.00
102	9,091	9.091	3.031	3.031	0.001	0.00	0.00	0.00	0.00	0.00
480	9.908	9.901	9.91	9.893		0.17	0.10	0.19	0.02	1
864	9.912	9.887	9.912	9.892		0.21	-0.04	0.21	0.01	
2856	9.913	9.881	9.914	9.915		0.22	-0.10	0.23		
2976	9.915	9.876	0.001	9.896	9.9298	0.24	-0.15	0.40	0.05	0.39
3096	9.89	9.857	9.931	9.887		-0.01	-0.34	0.40	-0.04	
4008	9.91	9.895	9.912	9.896		0.11	-0.07	0.22	0.05	
	0.002	0.004								
000000000000000000000000000000000000000					Thicknes	Thickness Gain	Thickness Gain	Thickness Gain	Thickness Gain	Thickness Gain
ULL R	Thickness	Thickness	Thickness	Thickness	THERICAL	Maaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa	habaabuaaaa		10010000000	
(h)	Thickness (mm)	Thickness (mm)	Thickness (mm)	Thickness (mm)	(mm)	(%)	(%)	(%)	(%)	(%)
(h)	Thickness (mm) 23°C/air	(mm) 80°C/air	Thickness (mm) B0/15RME	(mm) 80/100RME	(mm) 23/100RME	(%) 23°C/air	(%) 80°C/air	(%) 80/15RME	(%) 80/100RME	(%) 23/100RME
(h)	Thickness (mm) 23°C/air 4.112	Thickness (mm) 80°C/air 4.112	Thickness (mm) 80/15RME 4.112	Thickness (mm) 80/100RME 4.112	(mm) 23/100RME 4.112	(%) 23°C/air 0.00	(%) 80°C/air 0.00	(%) 80/15RME 0.00	(%) 80/100RME 0.00	(%) 23/100RME 0.00
(h) 0 192	Thickness           (mm)           25°C/air           4.112           4.119           4.117	Thickness (mm) 80°C/air 4.112	Thickness (mm) 80/15RME 4.112	Thickness (mm) 80/100RME 4.112	(mm) 23/100RME 4.112	(%) 23°C/air 0.00 0.17 0.12	(%) 80°C/air 0.00	(%) 80/15RME 0.00	(%) 80/100RME 0.00	(%) 23/100RME 0.00
0 192 480 864	Thickness           (mm)           23°C/air           4.112           4.119           4.117           4.115	Thickness (mm) 80°C/air 4.112 4.076 4.096	Thickness (mm) 80/15/PME 4.112 4.101 4.101 4.104	Thickness (mm) 80/100RME 4.112 4.099 4.099	(mm) 23/100RME 4.112	(%) 23°C/air 0.00 0.17 0.12 0.07	(%) 80°C/air 0.00 -0.88 -0.39	(%) 80/15RME 0.00 -0.27 -0.19	(%) 80/100RME 0.00 -0.32 -0.32	(%) 23/100RME 0.00
(h) 0 192 480 864 2856	Thickness (mm) 23°C/air 4.112 4.119 4.117 4.115 4.172	Thickness (mm) 80°C/air 4.112 4.076 4.096 4.094	Thickness (mm) B0/15FME 4.112 4.101 4.104 4.104 4.117	Thickness (mm) 80/100RME 4.112 4.099 4.099 4.098	(mm) 23/100RME 4.112	(%) 23°C/air 0.00 0.17 0.12 0.07 1.46	(%) 80°C/air 0.00 -0.88 -0.39 -0.44	(%) 80/15PME 0.00 -0.27 -0.19 0.12	(%) 80/100RME 0.00 -0.32 -0.32 -0.34	(%) 23/100RME 0.00
(h) 0 192 480 864 2856 2976	Thickness         (nun)           23°C/air         4.112           4.119         4.117           4.117         4.115           4.172         4.118	Thickness (mm) 80°C/air 4.112 4.076 4.096 4.094 4.094	Thickness (mm) B0/15FME 4.112 4.101 4.101 4.104 4.117	Thickness (mm) 80/100RME 4.112 4.099 4.099 4.099 4.098 4.071	4.1737	(%) 23°C/air 0.00 0.17 0.12 0.07 1.46 0.15	(%) 80°C/air 0.00 -0.88 -0.39 -0.44 -0.44	(%) 80/15RME 0.00 -0.27 -0.19 0.12	(%) 80/100RME 0.00 -0.32 -0.32 -0.34 -1.00	(%) 23/100RME 0.00 1.50
0 (h) 192 480 864 2856 2976 3096	Thickness           (mm)           23°C/air           4.112           4.119           4.117           4.115           4.172           4.118           4.108	Thickness (mm) 80°C/air 4.112 4.076 4.096 4.094 4.094 4.094 4.122	Thickness (mm) 80/16RME 4.112 4.101 4.101 4.104 4.117 4.137	Thickness (mm) 80/100RME 4.112 4.099 4.099 4.099 4.098 4.071 4.139	(mm) 23/100RME 4.112 4.1737	(%) 23°C/air 0.00 0.17 0.12 0.07 1.46 0.15 -0.10	(%) 80°C/air 0.00 -0.88 -0.39 -0.44 -0.44 -0.44 0.24	(%) 80/15RME 0.00 -0.27 -0.19 0.12 -0.61	(%) 80/100RME 0.00 -0.32 -0.32 -0.34 -1.00 0.66	(%) 23/100AME 0.00 1.50
(h) 0 192 480 864 2856 2976 3096 4008	Thickness           (mm)           23*C/air           4.112           4.117           4.115           4.117           4.117           4.118           4.108           4.138	Thickness           (mm)           80°C/air           4.112           4.076           4.096           4.094           4.122           4.175	Thickness (mm) B0155ME 4.112 4.101 4.104 4.104 4.117 4.137 4.137 4.139	Thickness (mm) 80/100RME 4.112 4.099 4.099 4.099 4.098 4.071 4.139 4.152	(mm) 23/100RME 4.112 4.1737	(%) 23*C/air 0.00 0.17 0.12 0.07 1.46 0.15 -0.10 0.63 0.63	(%) 80°C/air 0.00 -0.88 -0.39 -0.44 -0.44 0.24 1.53 0.55	(%) 80/15RME 0.00 -0.27 -0.19 0.12 -0.12 -0.61 0.66	(%) 80/100RME 0.00 -0.32 -0.32 -0.34 -1.00 0.66 0.97 0.59	(%) 23/100AME 0.00 1.50
une (h) 0 192 480 864 2856 2976 3096 4008 5016	Thickness           (mm)           23°C/alr           4.112           4.117           4.117           4.117           4.117           4.117           4.118           4.108           4.138           4.149	Thickness           (mm)         80°C/air           4.112         -           4.076         -           4.094         -           4.094         -           4.175         -	Thickness (mm) 80156ME 4.112 4.101 4.104 4.104 4.117 4.137 4.139 4.149	Thickness (mm) 80/100RME 4.112 4.099 4.099 4.099 4.098 4.071 4.139 4.152 4.136	(mm) 23/100RME 4.112 4.1737	(%)         23*C/air           0.00         0.17           0.12         0.07           1.46         0.15           -0.10         0.63           0.90         0.90	(%) 80°C/air 0.00 -0.88 -0.39 -0.44 -0.44 -0.44 1.53 0.15	(%) 80/15/8ME 0.00 -0.27 -0.19 0.12 -0.12 -0.61 0.66 0.90	(%) 80/100RME 0.00 -0.32 -0.32 -0.34 -1.00 0.66 0.97 0.58	(%) 23/100AME 0.00 1.50

## Table 6. Influence of diesel/RME and RME on PA12

m         (MPa)         DD (Ma) <thdd (da)<="" th=""> <thdd (da)<="" <="" th=""><th>time</th><th>Modulus</th><th>Modulus</th><th>Modulus</th><th>Modulus</th><th>Modulus</th><th>Modulus</th><th>Modulus</th><th>Modulus</th></thdd></thdd>	time	Modulus	Modulus	Modulus	Modulus	Modulus	Modulus	Modulus	Modulus
Image         28*C/air         28*C/air         28*C/air         28*C/air         28*C/air         28*C/air         24*/air         45         124         45         124         45         124         45         124         45         124         45         124         45         124         45         124         45         124         45         124         45         124         45         124         45         124         46         1005         28           300         1110         65         1353         90         911         61         962.6         45           3024         1003         18         1413         119         943         42         938.8         92.5           Ime         yield stress         yield stress </td <td>(th)</td> <td>(MPa)</td> <td>SD (MPa)</td> <td>(MPa)</td> <td>SD (MPa)</td> <td>(MPa)</td> <td>SD (MPa)</td> <td>(MPa)</td> <td>SD (MPa)</td>	(th)	(MPa)	SD (MPa)	(MPa)	SD (MPa)	(MPa)	SD (MPa)	(MPa)	SD (MPa)
0         1234         45         1234         45         1234         45         124         46           380         1172         45         1385         20         1142         45         1008         26           380         1172         45         1385         20         1142         45         1008         26           2016         5         1383         90         911         61         962.6         45           30224         1093         18         1413         119         943         42         938.8         32.5           time         yield stress		23°C/air	23°C/air	80°C/air	B0°C/air	80°C/Diesel-RME15%	80°C/Diesel-BME15%	80°C/RME100%	80°C/RME100%
120         124         45         1256         07         122         46         108           360         1172         45         1353         90         1142         48         1013         66           2016         1010         85         1953         90         1142         48         1013         66           2016         1033         18         1413         119         943         42         993.8         32.5           trae         yield stress	0	1234	45	1234	45	1234	45	1234	45
350         1172         45         1385         20         1142         46         1065         26           2016         1110         85         1353         90         911         61         992,6         46           2016         1093         18         1413         119         943         42         939,8         322,5           Imme         yield stress	120	1234	45	1255	67	1222	45		
1033         1110         85         1333         90         111         61         1913         66           3034         1003         18         1413         119         943         42         998.8         322.5           tma         yield stress	360	1172	45	1365	20	1142	48	1085	26
2016         110         01         982.6         45           30241         1093         18         1413         119         949         42         939.8         32.5           time         yield stress         sort/mitions         sort/mitions<	1008	1110	85	1353	90			1013	66
3024         1003         18         1413         119         949         42         938.8         32.5           time         yield stress	2016		0	1000		911	61	962.6	45
Imme         yield stress	3094	1093	18	1413	119	943	42	938.8	32.5
time         yield stress         SD (MPa)         SD (MPa) <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>									
Imme         yleid stress									
(h)         (h/Pa)         (b/Pa)         (b/Pa) <th(b pa)<="" th=""> <th(b pa)<="" th=""></th(b></th(b>	time	vield stress	vield stress	vield stress	vield stress	yield stress	yield stress	yield stress	yield stress
23°Craint         23°Craint         80°C/TME100%         80°C/TME100%         80°C/TME100%         80°C/TME100%           0         40.02         0.45         40.02         0.45         40.02         0.45           350         38.84         0.21         44.73         0.11         41.1         0.38         40.36         0.48           1008         38.06         0.37         44.81         0.51         40.21         0.27         40.05         0.33         0.27           3004         37.54         0.22         46.15         0.17         39.99         0.12         39.73         0.27           sized strain         yield strain </td <td>(h)</td> <td>(MPa)</td> <td>SD (MPa)</td> <td>(MPa)</td> <td>SD (MPa)</td> <td>(MPa)</td> <td>SD (MPa)</td> <td>(MPs)</td> <td>SD (MPa)</td>	(h)	(MPa)	SD (MPa)	(MPa)	SD (MPa)	(MPa)	SD (MPa)	(MPs)	SD (MPa)
0         40.02         0.46         40.02         0.45         40.02         0.45           180         40.02         0.46         43.54         0.85         42.05         0.28         40.99         0.27           3560         38.94         0.21         44.73         0.11         41.1         0.38         40.36         0.46           1008         30.66         0.37         44.81         0.51         40.21         0.27         40.06         0.33           2016         30.65         0.32         39.73         0.25         39.73         0.25           3024         37.54         0.22         46.15         0.17         39.99         0.12         39.73         0.25           imme         yield strain		23°C/air	23°C/air	80°C/air	80°C/air	80°C/Diesel-RME15%	80°C/Diesel-RME15%	80°C/RME100%	80°C/RME100%
120         40.02         0.46         44.54         0.85         42.05         0.26         40.99         0.27           3560         38.94         0.21         44.73         0.11         41.1         0.38         40.36         0.48           1008         38.06         0.37         44.81         0.51         40.21         0.27         40.06         0.33           2016         0.32         39.73         0.22         39.73         0.27           3024         37.54         0.22         46.15         0.17         39.65         0.32         39.73         0.27           start         yield strain         yield	Ö	40.02	0.45	40.02	0.45	40.02	0.45	40.02	0.45
350         38.04         0.21         44.73         0.11         41.1         0.38         40.36         0.48           1600         38.06         0.37         44.81         0.51         40.21         0.27         40.05         0.39           2016	120	40.02	0.45	43.54	0.85	42.05	0.26	40.99	0.27
1000         38.06         0.37         44.81         0.51         40.21         0.27         40.05         0.33           2016	350	38.94	0.21	44.73	0.11	41.1	0.38	40.36	0.48
2015         0.0         0.0         39.65         0.32         39.73         0.27           3024         37.54         0.22         46.15         0.17         39.99         0.12         39.73         0.25           time         yield strain	1008	38.06	0.37	44.81	0.51	40.21	0.27	40.05	0.33
3024         37.54         0.22         46.15         0.17         39.98         0.12         39.73         0.25           Ime         yield strain         yield strai	2016	00.00	0.07			39.65	0.32	39.73	0.27
time         yield strain	3024	37 54	0.22	46.15	0.17	39.98	0.12	39.73	0.25
time         yield strain		07.04	0.22	40.10					
time         yield strain									
(h)         (%)         SD (%)         (%)         SD (%)         (%)         SD (%)	time	vield strain	vield strain	vield strain	vield strain	vield strain	vield strain	vield strain	vield strain
Image: stress break         stress	(b)	(9/-)	SD (%)	(%)	SD /%)	(%)	SD (%)	(%)	SD (%)
0         10.65         0.52         10.65         0.52         10.65         0.52           120         10.65         0.52         11.82         0.95         12.72         0.78         14.13         0.71           380         11.73         0.47         11.29         0.22         13.5         0.68         14.59         0.4           1008         11.63         0.5         11.61         0.92         14.26         0.84         15         0.47           2016           16.52         0.89         16.36         0.69           3024         12.43         0.6         11.2         0.55         16.44         0.48         16.17         0.56           3024         12.43         0.6         11.2         0.55         16.44         0.49         16.17         0.56           imme         stress break         stress break <t< td=""><td></td><td>23°C(air</td><td>93°C/air</td><td>BO*C/air</td><td>80°C/air</td><td>80°C/Diesel-BME15%</td><td>80°C/Diesel-BME15%</td><td>80°C/BME100%</td><td>80°C/BME100%</td></t<>		23°C(air	93°C/air	BO*C/air	80°C/air	80°C/Diesel-BME15%	80°C/Diesel-BME15%	80°C/BME100%	80°C/BME100%
1000         11.13         0.47         11.29         0.22         13.5         0.68         14.59         0.4           1008         11.63         0.5         11.61         0.92         14.26         0.84         15         0.47           2016		10.65	0.52	10.65	0.52	10.65	0.52	10.65	0.52
120         10.03         0.047         11.29         0.22         13.5         0.68         14.59         0.4           3008         11.63         0.5         11.61         0.92         14.26         0.84         15         0.47           2016	100	10.05	0.52	11.82	0.02	12 72	0.78	14.13	0.71
300         11.7.5         0.47         11.25         0.22         14.26         0.05         14.05         0.47           3008         11.63         0.5         11.61         0.92         14.26         0.84         15         0.47           2016         -         -         16.52         0.89         16.36         0.69           3024         12.43         0.6         11.2         0.55         16.44         0.48         16.17         0.56           time         stress break         stres	250	11 72	0.02	11.02	0.33	13.5	0.68	14.59	0.4
1005         11.03         0.3         11.01         0.32         11.20         0.04         10.3         0.47           2016         16.52         0.89         16.36         0.69           3024         12.43         0.6         11.2         0.55         16.44         0.48         16.17         0.56           time stress break stress break stress break stress break stress break         stres	1009	11.63	0.47	11.25	0.22	14.26	0.00	15	0.47
2016         10.02         0.03         10.03         0.03           3024         12.43         0.6         11.2         0.55         16.44         0.48         16.17         0.56           lime         stress break         streas break         stress break         s	1000	11.03	0.5	11.01	0.92	16.50	0.04	16 36	0.69
3024         12.43         0.6         11.2         0.55         10.44         0.45         10.17         0.55           Ime         stress break         stress break<	2010	10.42		11.2	0.55	16.52	0.69	16.17	0.03
time         stress break	0024	12.43	0.0	11.2	0.55	10.44	0.40	10.17	0.50
Ime         stress break           (n)         (MPa)         SD (MPa)         (MPa)         SD (MPa)         (MPa)         SD (MPa)									
Internet         Stress Dream         Stress Dream <td></td> <td>etmen brook</td> <td>etroes brook</td> <td>etrees brook</td> <td>ofrees breek</td> <td>etrees braak</td> <td>etrose hreat</td> <td>stross brook</td> <td>stress break</td>		etmen brook	etroes brook	etrees brook	ofrees breek	etrees braak	etrose hreat	stross brook	stress break
Image         Strain break	JHRIB (H)	(MPa)	SD (MPa)	(MPa)	SD (MPa)	(MPa)	SD (MPa)	(MPa)	SD (MPa)
Lo Gail         Lo Gail <thlo gail<="" th=""> <th< td=""><td>μų</td><td>(INFA)</td><td>20°C/alt</td><td>BO<sup>o</sup>C(air</td><td>BO°C/alr</td><td>BOPC/Discol-BME15%</td><td>BOSCIDINE BUE15%</td><td>80°C/BME100%</td><td>80°C/BME100%</td></th<></thlo>	μų	(INFA)	20°C/alt	BO <sup>o</sup> C(air	BO°C/alr	BOPC/Discol-BME15%	BOSCIDINE BUE15%	80°C/BME100%	80°C/BME100%
10         34.29         2.40         34.29         2.40         34.29         2.40         34.29         2.40         34.29         2.40         34.29         2.40         34.29         2.40         34.29         2.40         34.29         2.40         34.29         2.40         34.29         2.40         34.29         2.40         34.29         34.49         2.67         51.26         6.87         34.29         34.39         35.95         2.05         34.49         2.67         51.26         6.87         34.4         34.4         34.29         34.4         35.95         2.05         34.4         34.4         34.4         34.4         34.4         34.4         34.4         34.4         34.4         34.4         34.4         34.4         34.4         34.4         34.4         34.4         34.7         34.4         34.4         34.4         34.7         34.4         34.4         34.4         34.4         34.7         34.4         34.4         34.4         34.4         34.6         34.4         34.4         34.4         34.4         34.4         34.4         34.4         34.4         34.4         34.4         34.4         34.4         34.4         34.4         34.4         34.4         3	0	54 00	20 0/84	54.20	2 46	54.20	2.46	54 20	246
120         34.2         248         30.49         0.09         34.49         2.07         0.120         0.120           360         51.27         0.4         47.48         8.53         51.95         0.78         52.95         2.05           1008         55.19         2.7         42.96         6.06         53.91         1.54         52.94         2.4           2016          51.61         1.41         51.28         1.08           3024         53.34         3.39         38.94         4.72         51.71         1.47         51.4         1.66           Ime         strain break         stra	400	54.29	2.40	50.40	6.00	54.25	2.40	51.26	6.87
300         31.27         0.4         47.46         0.36         0.15         0.15         0.250         2.00           1008         55.19         2.7         42.96         6.06         53.91         1.54         52.94         2.4           2016	021	54.2	2.40	47.49	9.53	51.95	0.78	52.95	2.05
1003         35.19         2.7         42.50         0.00         33.91         1.04         52.54         2.74	300	51.27	0.4	47.40	6.05	51.90	1.54	52.90	2.00
2016         31.51         1.41         31.25         1.06           3024         53.34         3.39         38.94         4.72         51.71         1.47         51.4         1.66           3024         53.34         3.39         38.94         4.72         51.71         1.47         51.4         1.66           1me         strain break	1008	55.19	2.1	42.90	0.00	53.91	1.04	51.09	1.09
Strain break         Strain break<	2010	E2 24	2 20	29.04	4 72	51.01	1.41	51.20	1.66
Ime         strain break	3024	53.34	3.39	30.94	4.12	51.71	1.47	51.4	1.00
Ime         strain break									
(h)         (%)         SD (%)         (%)	time	strain breek	strain break	strain break	strain break	strain break	strain break	strain break	strain break
23°C/air         23°C/air         80°C/air	(h)	(%)	SD (%)	(9/1)	SD /%)	(%1	SD (%)	(%)	SD (%)
Construction         Construction<	UU	23°C/sir	23ºC/air	80°C/air	80°C/air	80°C/Diesel-BME15%	80°C/Diesel-RMF15%	80°C/EME100%	80°C/BME100%
360         341.4         31.8         336.9         38         394.6         63.8         349.2         45           360         341.4         31.8         320.1         8.2         333.5         7         365.4         40           1008         414.3         13.1         322.1         8.5         350.4         20.9         379.1         42           2016         397.95         17.61         324.13         5.52         342.2         30.23         364.6         32		384 7	E0 60	384.7	52	384 7	52	384 7	52
300         31.4         31.8         320.1         8.2         333.5         7         365.4         40           1008         414.3         13.1         322.1         8.5         350.4         20.9         379.1         42           2016         3024         397.95         17.61         324.13         5.52         342.2         30.23         364.6         32	100	384.7	51.0	336.0	32	304.6	63.8	349.2	45
008         01.0         020.1         0.2         030.5         7         000.4         40           1008         414.3         13.1         322.1         8.5         350.4         20.9         379.1         42           2016         383.5         63.7         367.1         36           3024         397.95         17.61         324.13         5.52         342.2         30.23         364.6         32	120	341.3	31.0	320.5	80	333 5	7	365.4	40
10000         414.3         13.1         322.1         5.5         350.4         20.3         373.1         42           2016         383.5         63.7         367.1         36           3024         397.95         17.61         324.13         5.52         342.2         30.23         364.6         32	-360	341.4	31.0	320.1	0.2	355.5	20.0	370.1	40
3024 397.95 17.61 324.13 5.52 342.2 30.23 364.6 32	1008	414.3	13.1	366.1	0.0	393.5	63.7	367.1	36
	2010	207.05	1761	224 12	5.52	342.2	30.23	364.6	32
		397.93	17.01	024.10	0.02	074C.C	00.20	004.0	0.

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#### ¥.I. ¥.I. Y,I. Y.I. time (h) 23°C/air B0°C/air C/Diesel-RME1 B0°C/RME100% -32.251 -32.251 -32.251 -32.251 130 -31.21 -9.23 25.59 34.55 360 -31.02 4.83 49.38 58.56 21.13 1008 -32.251 59.407 68,476 2016 3024 74.767 85.856 -30.302 35.091 69.86 88.553 Mass gain Mass gain Mass gain Mass gain time (%mass) (%mass) C/Diesel-RME180°C/RME100% (%mass) 23°C/air (%mass) (h) 80°C/air 0.000 0.000 ( 0.000 0.060 120 360 1008 0.534 0.247 -0.171 0.434 0.894 0.673 0.356 -0.198 0.967 0.527 -0.215 1.333 2015 1.671 1.207 3024 0.713 -0.310 1.806 1.309 time Width Width Width Width Width Gain Width Gain Width Gain Width Gain (h) (mm) (നന) (mm) (mm) (%) (%) (%) (%) C/Diesel-RME180°C/RME100% 80°C/air 0°C/Diesel-RME159 80°C/RME100% 23°C/air 80°C/air 23°C/air 9.919 9.919 0.00 0.00 0.00 9.919 9.919 0.00 ന 120 9.917 9.941 9.927 9.919 0.00 -0.02 0.22 0.08 9.914 9.932 360 9.921 9.934 0.02 -0.05 0.15 0.13 9.917 9.956 1008 9.941 9.961 0.22 -0.02 0.42 0.37 9.979 0.74 2016 9.992 0.60 0.32 3024 9.951 9.913 9.986 9.956 -0.06 0.68 0.37 Thickness Thickness Thickness Thickness Thickness Gain Thickness Gain Thickness Gain Thickness Gain time (h) (mm) (mm) (mm) (mm) (%) (%) (%) (%) 23°C/sir 80°C/air C/Diesel-RME180°C/RME100% 23°C/air 80°C/air 0°C/Diesel-RME159 80°C/RME100% 4.049 4.049 4.049 4.049 0.00 0.00 0.00 0.00 . ^ 120 4.049 4.048 4.061 4.057 0.00 -0.02 0.30 0.20 4.041 4.062 4.057 360 4.046 -0.07 -0.20 0.32 0.20 4.077 4.05 4.069 0.69 1008 4.064 0.37 0.02 0.49 4.071 4.089 0.99 0.54 2016 3024 4.063 4.056 4.078 4.073 0.35 0.17 0.72 0.59

#### Table 7. Influence of diesel/RME and RME on PA12

## Table 8. Influence of diesel/RME and RME on HDPE

	Modulus .	Modulus	Modulus	Modulus	Modulate	Modulus
	RAIPATO INTERNE	SD (MPA)	(MPa)	SD(MPa)	(MPa)	BD (MPA)
	23°C/air	23°C/an	SO*C/mr	60°C/M	60"C/RIME100%	80°C/RME100%
0	777.8	19.6	777.8	19.6	777.8	
72			769.4	66	491.1	27.2
480	818.4	28.9	775.2	18.63		
984			823.6	26.3	524.3	22.5
1000	884.6	22.4	878.4	22.1	524.1	10
1992	820.4	18.7	799.8	17.4	528.4	17.8
8800088	867.2	18.8	888.1	19.6	545.1	22.1
8400038	844.1	7.8	897.2	47.3	513.1	18.7
5016	885.2	23.8	844.2	48.3	554.6	12.6
18Rotubbull9E						
19820866688	11111111111111111111111111111111111111	88866666787910000000000000	20030034101174440094082038	199993838389999999999999999999999999999	98999999999999999999999999999999999999	00000000000000000000000000000000000000
RESECTION			22222222222222222222222222222222222222	00000000000000000000000000000000000000	65000000 Joon Job Job 8000000000000000000000000000000000000	19999999999999999999999999999999999999
(h)	(MPa)	SID (MPA)	(MPB)	SDIMPO	(MPD)	
	28°C/uir	23°C/ak	BOTC/eir	60°0/ah	BOTC/FIME HOOS	BOTC/FIME 100%
0	24.56	0.17	24.56	0.17	24,56	0.17
72			24.63	0,13	23.48	0.69
480	24.44	0.16	24.86	0.12		
964			25.13	0.61	23.7	0.15
1000	25.27	0.08	25.97	0.1	22.83	Ô.16
1992	24.71	0.15	25.43	0.1	23.72	0.62
9000	25.22	0.09	25.94	0.07	24.18	0.17
4008	24.84	0.23	25.93	0.09	23.36	0.9
5016	24.86	0.22	25.69	0.08	24.29	0.09
1002000088	and the second se	1993 1994 Anna an	10000000000000000000000000000000000000	000000000000000000000000000000000000000	89888889999999999999999999999999999999	000000000000000000000000000000000000000
BERLANDER HERPAREDOR	18383333 asastatbaddillilli 18383333 asastatbaddillilli	BEERE CONTRACTOR CONTRACTOR	10000000 Andersheider Anders Andersheider Andersheider Andersheider Andersheider Andersheider A	Contractor to a contractor of the contractor of	BORDON Autobabaad Babaad	CONTRACTOR AND A DATE OF A
	23°C/m	23°C/m	SOTC/Mr	BO*C/air	BOY GARMENOOS	BOYC/FINE 100%
0	11.8	0.85	11.8	0.85	11.8	0.85
72			11.53	0.66	25.24	5.58
480	11.29	0.79	13.02	0.83		
984			12.43	0.57	22.62	1.9
1000	10.46	0.65	11.28	0.42	22.2	2.1
1992	10.27	0.11	12.05	0.71	24.07	1.24
3000	11.16	0.37	11.46	0.84	22.13	1.1
4006	10.8	0.41	11.57	0.62	24.83	2.15
5016	11.45	0.93	12.29	0.82	24.41	1.84
10050000000						
88840.0288	atreat break					some breek
in the	atreu: braak	SD MPA	sines break	stres tree:	Mana and	SD Mizzi
(ime (h)	Strens breek (MPa)	SD (MPA)	inter back	SDIWPO	Minist Stelk	SD (MPS)
	atrosa breek (MPa) 23°C/ar	SD (MPa) 24 C/Ar	Stress Freek (MPa) StrCar	stress break SD(MPa) 60*Dar 3.13	atrass Sreek (MPa) 807C/RME1005	SD (MPs) 60*C/FME1005
(me (h) 0	Stress breek (MPa) 23*C/ar 18.5	stress break SD (MPa) 23*Crair 3.13	stress break (MPa) 80°C/ek 18.5 17.49	struss break SD(MP.a) 60° C/as 3.13 2.61	80%27500 (MPa) 60%2771ME100% 18.5 20.44	strass brask SD (MPa) 60° C/RME 100% 3.13 1.79
(h) (h) 72	8tress tresk (MPa) 23*C/wr 18.5 17.57	stress break SD (MPa) 28°C/ak 3.13	8hriss braak (MPa) 80rC/sk 18.5 17.69 18.41	80(MPa) 60*C/ai 3.13 2.61	80mms brank (MPa) 80nC/FIME100% 18.5 20.44	stress basic SD (MPa) 60°C/RME100% 3.13 1.78
(h) 0 72 480	817mis breek (MPa) 23°C/ler 18.5 17.57	atries break SD (MPa) 23*Crair 3.13 2.34	strass break (MPa) 00°C/ai 18.5 17.69 16.41 17.57	athese break SD(MPa) 60°C/ai 3.13 2.61 1.7	80%85 break (MPa) 60%CRME 100% 18.5 20.44 20.37	100ms break SD (MPa) 00°C/RME100% 3.13 1.78
(h) 0 72 480 964	Strens breek (MPa) 23°C/W 18.5 17.57	stress break SD (MPa) 23*Clair 3.13 2.34	8tress brokk (MPa) 00nC/air 18.5 17.69 18.41 17.57 19.40	80%204 80%204 80%204 3.13 2.61 1.7 2 1.92	80%85 broak (MPa) 60%C/FME100% 10.5 20.44 20.37 10.9 10.9	SD (MPa) SD (MPa) SD (MPa) SD (C/RME 100% 3.13 1.78 1.57 0.52
(h) (h) 72 480 964 1000	817056 5706K (MPa) 23*C/nir 18.5 17.57 19.55	SD (MPa)           23/C/a/           3.13           2.34           2.13           0.21	8hras 8 break (MPa) 60mC/au 18.5 17.69 18.41 17.57 18.49 19.09	athese break SD(MFr) 60°C/se 3.13 2.61 1.7 2 1.63 2.66 1.7 2	8/mse break (MPa) 80%/RME100% 18.5 20.44 20.37 19.89 20.24	stress break SD (MPa) 60°C/RME 100% 3.13 1.78 1.57 0.92 0.92
(h) (h) 72 480 984 1000 1902	8 treas break (MPa) 23*C/w 18.5 17.57 19.55 20.9 10 cm	8trees break SD (MPe) 23°C/air 3.13 2.34 2.13 0.88 2.00	8tress break (MPa) 80°C/ak 18,5 17,69 16,41 17,57 18,49 19,98 40,09	these break SD(MPa) 60°C/air 3.13 2.61 1.7 2 1.83 2.28 2.00 2.00	struis break (MPa) 80°C/RME100% 18.5 20.44 20.37 18.89 20.24 20.24	stress break SD (MPa) 80°C/RME100% 3.13 1.78 1.57 0.82 0.89 4.90
(m) (h) 72 480 984 1000 1992 3000	80006 break (MPa) 28*Crist 18.5 17.57 10.55 20.9 17.85 20.9	stress break SD (MPa) 23°C/ak 3.13 2.34 2.13 0.88 2.66 2.66	etress break (MPie) 000C/ak 10,5 17,69 18,41 17,57 18,49 19,08 19,23 4,57	sheas break SD(MPa) 3.13 2.61 1.7 2 1.83 2.28 3.06 0.45	50%5 break (MPa) 60°C/TIME 100% 18.5 20.44 20.37 18.88 20.24 19.4 19.4 20.24	80 MAPa) 80 MAPa) 80 CRMAE 100% 3.13 1.78 1.57 0.82 0.89 1.86 0.72
(h) (h) 72 480 964 1000 1992 3000 4008	817056 5700K (MPa) 23*C/nir 18.5 17.57 10.55 20.0 17.65 16.52 16.52	80 (MPa) 237 (MPa) 237 (Mar 237 (Mar 2.34 2.13 0.86 2.66 1.53 0.57	etress break (MPa) 90°C/ar 18.5 17.60 18.41 17.57 18.49 19.08 19.23 18.74 19.23	etress break SD(MPa) 60° Crain 3.13 2.61 1.7 2 1.83 2.26 3.06 3.45 0.05	etress break (MPa) 8072744E1005 18.5 20.44 20.37 18.89 20.24 18.4 18.4 18.4	strons break SD (MPa) 80 (CFME 100% 3.13 1.78 1.57 0.92 0.89 1.66 2.72 1.57
(h) 0 72 480 984 1000 1992 3000 4008 5016	8 trens break (MPa) 23*Crie 18.5 17.57 20.9 17.65 20.9 17.65 16.52 16.52	8treen break SD (MPe) 23*C/air 3.13 2.34 2.13 0.86 2.66 1.53 3.32	Etress break (MPa) 80°C/ar 18.5 17.69 18.41 17.57 18.49 19.98 19.23 16.74 17.1	these break SD(MPa) 60°C/air 3.13 2.61 1.7 2 1.83 2.28 3.06 3.45 2.25	struss break (MPa) 80°C/RME100% 18.5 20.44 20.37 18.89 20.24 19.4 18.4 18.61	Noves break SD (MPa) 80°C/RWE100% 3.13 1.75 1.57 0.62 0.89 1.86 2.72 1.66
(h) (h) 72 480 964 1000 1992 3000 4008 5016	807096 Sreek (MPa) 28*Crivit 18.5 17.57 10.55 20.9 17.85 16.52 16.52 16.87	stress break SD (MPa) 23/Chair 3.13 2.34 2.13 0.66 2.66 1.53 3.32	stress break (MPa) 800C/ar 18.5 17.69 18.41 17.57 18.49 19.08 19.23 16.74 17.1	stress break           SO(MPa)           60°C/air           3.13           2.61           1.7           2           1.83           2.28           3.06           3.45           2.25	40%6 break (MPa) 80°C/TIME 100% 18.5 20.44 20.37 18.89 20.24 19.4 18.81 18.67	80 MAP a) 80 MAP a) 80 CPANE 100% 3.13 1.78 1.57 0.82 0.89 1.86 2.72 1.66
(m) 0 72 480 964 964 1000 1992 3000 4008 5016	8 treat break (MPa) 23*Crie 18.5 17.57 10.55 20.9 17.95 16.52 16.52	8trest break SD (MPa) 237C/air 3.13 2.34 2.13 0.86 2.66 1.53 3.32	etress break (MPa) 807C/ar 18.5 17.60 18.41 17.57 18.49 19.08 19.23 18.74 17.1	etress break SD(MPa) 60°C/air 3.13 2.61 1.7 2 1.83 2.26 3.06 3.06 3.45 2.25	etress breek (MPa) 8072744E1005 18.5 20.44 20.37 18.89 20.24 18.4 18.4 18.4 18.67	strons break ISD (MPa) 80/CFNE100% 3.13 1.78 1.57 0.92 0.89 1.86 2.72 1.66
(m) (h) 72 480 964 1000 1992 3000 4008 5016	8 trins break (MPa) 23*Crie 18.5 17.57 19.55 20.9 17.85 16.52 16.52 16.52 16.57	8treen break SD (MPe) 23*C/air 3.13 2.34 2.13 0.86 2.66 1.53 3.32 8trein break	Etress break (MPa) 00°C/ar 18.5 17.69 18.41 17.57 18.49 19.08 19.23 16.74 17.1 strain break	etress break SO(Wa) 60°C/de 3.13 2.61 1.7 2 1.83 2.26 3.06 3.45 2.25 2.25 strain break	stress break (UFIs) 60°C/FIME 100% 18.5 20.44 20.37 18.89 20.24 18.4 18.81 18.67 3train break	trans break 50 MPa 90°C/RME 100% 3.13 1.78 1.57 0.92 0.89 1.86 2.72 1.66 stain break
(h) 0 72 480 964 1000 1992 3000 4008 5016 11me (h)	80006 break (MPa) 23*Crini 18.5 17.57 19.55 20.9 17.85 16.52 16.52 16.87	SD (MPa) 23/C/ar 3.13 2.34 2.13 0.69 2.66 1.53 3.32 8train Dreak	etress break (NPa) 800C/ar 18.5 17.69 18.41 17.57 18.49 18.88 19.88 19.23 18.74 17.1 17.1	stress break     SO(MPa)     SO(MPa)     SO(Clair     3.13     2.61     1.7     2     1.83     2.28     3.06     3.45     2.25      strain break     SD Pol	strais break (MPa) 80°CPIME (50%) 18.5 20.44 20.37 19.89 20.24 18.4 18.4 18.61 18.67 387an break	80 (MPa) 80 (MPa) 80 (CPA) E 107% 3.13 1.78 1.57 0.92 0.89 1.66 2.72 1.66 2.72 1.66 81 (MPa) 81 (MPa)
(h) 0 72 480 984 1000 1982 3000 4006 5016	8 treats break (MPa) 23*Criet 18.5 17.57 19.55 20.9 17.85 16.52 16.52 16.52 16.67 8 tain break (%)	streen break SD (MPa) 237C/air 3.13 2.34 2.13 0.86 2.66 1.53 3.32 strain break SD (%)	etress break (MPa) 807C/ar 18.5 17.69 18.41 17.57 18.49 19.23 18.74 19.23 18.74 17.1 87ahr break (%)	etress break SD(MPa) 60°C/air 3.13 2.61 1.7 2 1.83 2.26 3.06 3.05 3.45 2.25 81min break SD (%)	etrese breek (MPa) 80°C/RME1005 18.5 20.44 20.37 18.89 20.24 18.4 18.4 18.4 18.67 81°C/RME105 81°C/RME105 (%)	strons break SD (MPa) 80 C/RME 100% 3.13 1.78 1.57 0.92 0.89 1.66 2.72 1.66 strain break SD (%) 90 C/RME 100%
(h) 0 72 480 964 1902 1992 3000 4008 5016 [Ime (h)	8 trins break (MPa) 23*C/w/ 18.5 17.57 19.55 20.0 17.65 20.0 17.65 16.52 16.52 16.52 16.57 3 ttain break (%)	stress break SD (MPa) 23*Crait 3.13 2.34 2.13 0.88 2.66 1.53 3.32 strain break 5D (%) 23*Crait	etress break (MPa) 80°C/ar 10,5 17,69 18,41 17,57 18,49 19,08 19,23 16,74 17,1 17,1 17,1 17,1 17,1	stress break           SD(MPa)           SD*Crait           3.13           2.61           1.7           2           1.83           2.26           3.06           3.45           2.25           strain break           SD (%)           60*Crait	Stries break (MPa) 60°C/HAE 100% 18.5 20.44 20.37 18.80 20.24 18.4 18.81 18.67 18.67 30°C/HAE 100%	80/647a) 80/747a) 80/75784E100% 3.13 1.78 1.57 0.92 0.89 1.86 2.72 1.66 81/81/0 treak 80/75784E100%
(h) 0 72 480 984 1000 1992 3000 4008 5016 11me (h)	8 tress break (MPa) 23*Crier 18.5 17.57 10.55 20.9 17.85 16.52 16.52 16.52 16.52 16.57 31tain break (%) (%)	street, break SD (MPa) 28°C/ai 3.13 2.34 2.13 0.89 2.66 1.53 3.32 strein break 5D (65) 23°C/ai 12.17	etress break (MPa) 800C/ar 18.5 17.69 18.49 19.08 19.08 19.23 16.74 17.1 17.1 strain break (%) 500C/ar 67.56	atress break           SD(MPa)           60*C/air           3.13           2.61           1.7           2           1.83           2.28           3.06           3.45           2.25           strain break           SD(%)           60*C/air           12.17	stress breek (MPs) 80°C7RIAE1005 18.5 20.44 20.37 19.89 20.24 18.4 18.61 18.67 30°C7RIAE1005 60°C7RIAE1005 67.56	80 (MPa) 80 (MPa) 80 (CRME 107) 3.13 1.78 1.57 0.92 0.89 1.86 2.72 1.66 81 (m)
(h) 0 72 480 964 1000 1992 3000 4006 5016 11me (h) 0 72	8 treas break (MPa) 23*C/w 18.5 17.57 19.55 20.9 17.85 16.52 16.52 16.87 8 train break (%) 23*C/at 67.56	stress break           SD (MPa)           23°C/air           3.13           2.34           2.13           0.66           1.53           3.32           strain break           SD (%)           23°C/air           12.17	etress break (MPa) 807C/ar 18.5 17.69 18.41 17.57 18.49 19.06 19.23 18.74 17.1 81rain break (%) 507C/ar 67.56 68.97	ethese breek SO(MPa) 60°C/det 3.13 2.61 1.7 2 1.83 2.26 3.06 3.45 2.25 2.25 strain breek SD (%) 60°C/det 12.17 12.47	Stress break           (MHe)           BCCFIME 100%           18.5           20.44           20.37           18.89           20.24           18.4           18.67           Strain break           (%)           60°C/RME 100%           67.56           78.62	trans break SD (MPa) OPC/RME 100% 3.13 1.78 1.57 0.92 0.89 1.86 2.72 1.66 80°C/RME 100% 80°C/RME 100% 12.17 2.3.43
(h) 0 72 480 964 1000 1992 3000 4006 5016 10me (h) 0 72 480	817ms break (MPa) 23*C/w/ 18.5 17.57 19.55 20.9 17.85 16.52 16.52 16.52 16.57 818/n break (%) 23*C/w/ 67.56 67.09	stress break SD (MPa) 23*C/air 3.13 2.34 2.34 2.33 0.66 2.66 1.53 3.32 strein break SD (%) 23*C/air 12.17 18.67	stress break           (MPa)           80nC/air           10.5           17.69           18.41           17.57           18.49           19.08           19.23           16.74           17.1           strain break           (%)           50nChair           67.56           68.97           83.66	stress break           SD(MPa)           SD*Clair           3.13           2.61           1.7           2           1.83           2.26           3.06           3.45           2.25           strain break           SD (%)           sorClair           12.17           12.47           19.44	40% break (MPa) 80°C7IME100% 18.5 20.44 20.37 18.89 20.24 19.4 18.81 18.67 19.4 18.81 18.67 (%) 60°C7IME100% 67.56 78.92	80 MAP a) 80 MAP a) 80 CRMAE 100% 3.13 1.78 1.57 0.82 0.89 1.86 2.72 1.66 81 all break SD (%) 80 °C/RME 100% 12.17 23.43
(h) 0 72 4800 984 1000 1992 3000 4008 5016 (ime (h) 0 72 4800 804 804 804 804 804 804 80	8 treat break (MPa) 23*Criet 18.5 17.57 19.55 20.9 17.85 16.52 16.52 16.52 16.57 8 tain break (%) 23*Criet 67.56 67.09	stream break           SD (MPa)           28°C/ait           3.13           2.34           2.13           0.80           2.66           1.53           3.32           strain break           SD (%)           23°C/ait           12.17           18.67	etress break (MPa) 90°C/ar 18.5 17.69 18.41 17.57 18.49 19.98 19.23 16.74 17.1 17.1 17.1 17.1 17.1 50°C/ar 67.56 68.97 83.66 73.79	atress break           SD(MPa)           60*C/air           3.13           2.61           1.7           2           1.83           2.26           3.06           3.45           2.25           strain break           SD (%)           60*C/air           12.17           12.47           12.47           19.44           12.56	stress break (MPs) 80°C/RME1005 18.5 20.44 20.37 19.89 20.24 16.4 18.61 18.67 30°C/RME1005 67.56 78.92 78.45	stress break SD (MPa) 80°C/RME 100% 3.13 1.78 1.57 0.92 0.89 1.66 2.72 1.66 3.72 1.66 80°C/RME 100% 12.17 2.3.43 12.46
(h) 0 72 480 984 1000 1992 3000 4008 5016 1008 5016 0 72 480 984 1000 72 480 984 1000 1007 1	8 trons break (MPa) 23*Crie 18.5 17.57 19.55 20.9 17.85 16.52 16.55 16.52 15.56 15.56 15.52 15.53 15.53 15.53 15.53 15.53 15.53 15.53 15.53 15.54 15.54 15.54 15.54 15.54 15.54 15.54 15.54 15.54 15.54 15.54 15.54 15.54 15.54 15.54 15.54 15.55 15.55 1	stress break SD (MPe) 23*Crain 2.34 2.34 2.34 2.34 2.66 1.53 3.32 3.32 strein break SD (%) 23*Crain 12.17 18.67 14.36	etrass break (MPie) 900C/ar 10.5 17.69 16.41 17.57 18.49 19.23 16.74 17.1 17.1 17.1 17.1 87/ar 67.56 68.97 83.66 73.79 66.76	stress break           SD(MPa)           60*Clair           3.13           2.61           1.7           2           1.83           2.26           3.06           3.45           2.25           strain break           SD (%)           80*Crair           12.17           12.47           19.44           12.56           7.15	stress break           (MPs)           60°C/HAE 100%           18.5           20.44           20.37           10.86           20.24           18.4           18.5           80°C/RME 100%           67.56           78.92           78.45           62.66	attense break           SD (MPra)           00*C/RME 100%           3.13           1.78           1.57           0.92           0.89           1.66           2.72           1.66           80*C/RME 100%           12.17           23.43           12.46           8.73
(h) 0 72 480 984 1000 1992 3000 4008 5016 1992 0 72 480 984 984	atress break           (MPa)           23*Crist           18.5           17.57           10.55           20.9           17.85           16.52           17.56           55.34           40.23	stress break SD (MPa) 23/C/ar 3.13 2.34 2.13 0.88 2.66 1.53 3.32 strain Dreak SD (%) 23/C/ar 12.17 18.67 14.36 9.87	etress break (MPa) 80°C/air 18.5 17.69 18.41 17.57 18.49 19.98 19.23 16.74 17.1 23 16.74 17.1 50°C/air 67.56 68.97 83.66 73.79 66.76 64.06	stress break           SO(MPa)           60°C/air           3.13           2.61           1.7           2           1.83           2.26           3.06           3.45           2.25           strain break           SD (%)           sor C/air           12.17           12.47           19.44           12.56           7.15           10.15	40%6 break (MPa) 80°CPIME 100% 18.5 20.44 20.37 19.89 20.24 19.4 18.61 18.67 19.4 18.67 19.4 18.67 (%) 80°CPIME 100% 67.56 77.69 78.45 62.95 77.91	80 (MPa) 80 (MPa) 80 (CPAE 107) 3.13 1.78 1.57 0.52 0.89 1.86 2.72 1.66 80 (%) 80*C/PME1007, 12.17 23.43 12.46 8.73 10.66
(h) 0 72 480 964 1992 3000 4008 5016 1992 3000 4008 5016 1992 3000 4008 5016 1992 3000 4008 5016 1992 3000 4008 5016 1992 3000 4008 5016 1992 3000 4008 5016 1992 3000 4008 5016 1992 3000 4008 5016 1992 3000 4008 5016 1992 3000 4008 5016 1992 3000 4008 5016 1992 3000 4008 5016 1992 3000 4008 5016 1992 3000 4008 5016 1992 3000 1992 3000 4008 5016 1992 3000 1992 3000 1992 3000 1992 3000 1992 1992 3000 1992 3000 1992 3000 1992 3000 1992 3000 1992 3000 1992 3000 1992 3000 1992 3000 1992 3000 1992 1995 19	Bitrees         Dreak           (MPe)         23*Criet           18.5         17.57           19.55         20.9           17.65         16.52           16.52         16.52           16.57         55.34           68.97         67.79	stream break           SD (MPa)           23°C/air           3.13           2.34           2.13           0.86           2.66           1.53           3.32           strain break           SD (%)           23°C/air           12.17           18.67           14.36           9.87           10.35	etress break (MPa) 90°C/ar 18.5 17.60 18.41 17.57 18.49 19.98 19.23 16.74 17.1 17.1 16.74 17.1 50°C/ar 67.56 68.97 83.66 73.70 66.76 64.06 65.97	etress break SD(MPa) 60°C/air 2.61 1.7 2 1.83 2.26 3.45 2.25 strain break SD (%) 60°C/air 12.17 12.47 19.44 12.56 7.15 19.15	stress break (MPa) 80°C/RHE100% 18.5 20.44 20.37 18.89 20.24 18.4 18.4 18.4 18.61 18.67 30°ar break (%) 80°C/RHE100% 67.56 78.92 78.45 62.95 77.91 70.17	attense break           SD (MPa)           ov(CRM4 tops)           3.13           1.78           0.92           0.89           1.66           8/16/07           80 (MPa)           80 (MPa)<
(h) 0 72 480 964 1992 3000 4006 5016 (h) 0 72 480 964 1992 3000 4008 5016 (h) 0 72 480 964 1992 3000 4008 5016 1992 3000 4008 5016 1992 3000 4008 5016 1992 3000 4008 5016 1992 3000 4008 5016 1992 3000 4008 5016 1992 3000 4008 5016 1992 3000 4008 5016 1992 3000 4008 5016 1992 1007	8 trons break (MPa) 23*C/w 18.5 17.57 19.55 20.9 17.85 16.52 16.52 16.57 3tain break (%) 23*C/w 67.56 57.34 48.23 68.97 88.07	stress break SD (MPa) 23°C/air 2.34 2.13 2.34 2.13 0.68 2.66 1.53 3.32 strain break SD (%) 23°C/air 12.17 18.67 14.36 9.67 10.35 37.14	atracs break           (MPa)           80°C/at           10.5           17.69           18.41           17.57           18.49           19.23           16.74           17.1           atrain break           (%)           50°C/at           65.67           65.67           65.97           75.06	stress break           SD(MPa)           SD*Clair           3.13           2.61           1.7           2           1.83           2.26           3.06           3.45           2.25           strain break           SD (%)           60*Clair           12.17           12.47           18.44           12.56           7.15           19.15           19           12.63	Stress break           (MPa)           BC/CriMe 100%           16.5           20.44           20.37           10.89           20.24           19.4           18.81           18.67           Strink break           (%)           60*C/RME 100%           67.56           78.92           78.45           62.95           77.91           70.17           82.07	80 MAP a) 80 MAP a) 80 MAP a) 80 MAP a) 1.78 1.57 0.82 0.89 1.86 2.72 1.66 81 a) break 80 C/RME 100% 12.17 23.43 10.66 8.42 18.19

## CA.97.20683

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## Table 9. Influence of diesel/RME and RME on HDPE

Initian         Initian         Initian         Initian           0         16.54         16.554         60°C/Air         60°C/Air/E100%           0         -16.554         -16.554         -16.554         16.554           480         -15.959         -15.685         -16.71           1992         -16.99         -15.36         -16.412           1992         -16.99         -15.36         -14.015           3000         -15.601         -13.27         -16.659           4008         -16.034         -12.967         -16.199           5016         -15.576         -11.892         -16.143           Vaight 6 bars         Weight 6 bars         Mess gain         Mess gain         Mess gain           0         43.631         43.631         0.00         0.00         0           72         43.649         45.843         0.10         0.03         984           43.651         43.651         43.641         0.00         0.00         0           72         43.649         45.843         0.04         5           480         43.651         46.65         45.871         0.02         0.08         5           1992	Internal         Internal           60°C/air         60°C/RME100%           -16.554         -16.554           -15.665         -16.71           -15.108         -16.861           -15.3         -16.412           -15.3         -16.412           -15.3         -16.412           -15.3         -16.101           -13.27         -16.659           -12.967         -16.199           -11.892         -16.143           Velght 6 bars         Mess gain         Mess gain           (g)         (g)         (%mass)         (%mass)           60°C/as         60°C/RME100%         23°C/as         60°C/mic         8           43.631         43.631         0.00         0.00         43.649           43.649         45.843         0.04         43.644         0.07           43.661         46.044         0.07         43.665         45.871         -0.02         0.08           43.701         45.862         0.08         0.16         43.756         45.847         0.04         0.29           43.704         45.827         0.07         0.17         0.17         0.17           Wath         Width<	International         Vision International         Vision International           0         -16.554         -16.554         -16.554           0         -16.554         -16.554         -16.554           22         -15.665         -16.71           30         -15.959         -15.639           34         -15.108         -16.861           00         -16.095         -15.4           92         -16.091         -13.27           16.659         -15.4         -16.199           00         -15.601         -13.27           16.659         -16.143           00         -15.576         -11.892           116         -15.576         -11.892           118         -15.576         -0.11.892           118         -15.576         -0.11.892           118         -15.576         -0.11.892           118         -15.576         -0.11.892           118         -15.576         -0.11.892           118         -15.576         -0.12.89           10         (0)         (Vernas)         (Vernas)           287C/as         60°C/as         60°C/as         60°C/as           0         43.
Unit         23°C/Air         B0°C/Bir         B0°C/RH/E 100%,           0         -16.554         -16.554         -16.554           72         -15.655         -16.71           480         -15.959         -15.639           984         -15.108         -16.851           1000         -16.095         -15.4           11922         -16.99         -15.36           3000         -15.01         -13.27           11.327         -16.659           40008         -16.034           -12.967         -16.143           0         (g)         Vermax)           0         (g)         (g)         Vermax)           0         43.631         43.631         43.631           0         43.631         43.649         45.843           0.04         43.644         0.10         0.03           984         43.661         46.044         0.07         5           10900         43.657         43.641         45.868         0.06         0.02         5           1982         43.661         46.044         0.07         5         5           1000         43.665         43.756         4	BOTC/air         BOTC/FM/E100%           -16.554         -16.554           -15.665         -16.71           -15.685         -16.71           -15.685         -16.71           -15.339         -           -15.108         -16.861           -15.4         -16.412           -15.36         -14.015           -13.27         -16.659           -12.967         -16.199           -11.892         -16.143           Weight 6 bars         Weight 6 bars         Mess gain           10         (9)         (%mass)         (%mass)           60*Crail         60*Crail         00*Crail         9           43.631         43.631         0.00         0.00           43.644         0.10         0.03         43.644           43.655         45.871         -0.02         0.08           43.661         46.044         0.07         43.665           43.756         45.847         0.04         0.29           43.756         45.847         0.04         0.29           43.764         45.927         0.07         0.17           Woth         Woth Gain         Woth Gain         Woth Gain </th <th>23°C/air         60°C/RME 100%           0         -16.554         -16.554           2         -15.655         -16.71           30         -15.959         -15.639           34         -15.108         -16.851           00         -15.959         -15.639           34         -15.108         -16.861           00         -15.69         -15.36           00         -15.601         -13.27           00         -15.601         -13.27           016         -15.676         -11.892           016         -15.576         -11.892           016         -15.576         -11.892           016         -16.334         -12.967           017         (0)         (0)           (1)         (0)         (%mas)           (2)         (0)         (9)           (2)         43.631         43.631         0.00           0         43.674         43.644         0.10         0.03           24         43.661         46.044         0.07         5.53           00         43.624         43.665         45.871         -0.02         0.08         5.13</th>	23°C/air         60°C/RME 100%           0         -16.554         -16.554           2         -15.655         -16.71           30         -15.959         -15.639           34         -15.108         -16.851           00         -15.959         -15.639           34         -15.108         -16.861           00         -15.69         -15.36           00         -15.601         -13.27           00         -15.601         -13.27           016         -15.676         -11.892           016         -15.576         -11.892           016         -15.576         -11.892           016         -16.334         -12.967           017         (0)         (0)           (1)         (0)         (%mas)           (2)         (0)         (9)           (2)         43.631         43.631         0.00           0         43.674         43.644         0.10         0.03           24         43.661         46.044         0.07         5.53           00         43.624         43.665         45.871         -0.02         0.08         5.13
D         -16.554         -16.554         -16.554         -16.554           72         -15.665         -16.71           480         -15.959         -15.339           984         -15.108         -16.661           10000         -16.095         -15.4           1992         -16.99         -15.36           4008         -16.51         -14.015           3000         -15.601         -13.27           -16.659         -16.034         -12.967           6006         -16.034         -12.967           5016         -15.576         -11.892           1         10         (g)         (values)           2xrCkie         60°C/kie         60°C/kie           0         43.631         43.631         43.631           43.644         0.10         0.03           984         43.661         46.044           0.07         2           1992         43.661         46.044           0.07         2           1992         43.661         46.044           0.07         2           1992         43.665         45.871           3000         43.665         43.	Name         Name <th< td=""><td>D         -16.554         -16.554         -16.554           2         -15.665         -16.71           30         -15.959         -15.639           34         -15.108         -16.651           000         -16.095         -15.4           010         -15.601         -13.27           02         -15.576         -11.892           030         -15.576         -11.892           116         -15.576         -11.892           116         -15.576         -11.892           116         -15.576         -11.892           116         -15.576         -11.892           116         -15.576         -11.892           116         -15.576         -11.892           116         -15.576         -11.892           116         -15.576         -11.892           118         60°C/646         60°C/646           00         43.631         43.631         0.00         0.00           12         43.649         45.843         0.04         5.07           20         43.661         46.044         0.07         5.53           100         43.674         43.665         45.871</td></th<>	D         -16.554         -16.554         -16.554           2         -15.665         -16.71           30         -15.959         -15.639           34         -15.108         -16.651           000         -16.095         -15.4           010         -15.601         -13.27           02         -15.576         -11.892           030         -15.576         -11.892           116         -15.576         -11.892           116         -15.576         -11.892           116         -15.576         -11.892           116         -15.576         -11.892           116         -15.576         -11.892           116         -15.576         -11.892           116         -15.576         -11.892           116         -15.576         -11.892           118         60°C/646         60°C/646           00         43.631         43.631         0.00         0.00           12         43.649         45.843         0.04         5.07           20         43.661         46.044         0.07         5.53           100         43.674         43.665         45.871
72         -15.000         15.000         15.000         15.000         15.000         16.001         16.001         16.001         16.001         16.001         16.001         16.001         16.001         16.001         16.001         16.001         16.001         16.001         16.001         16.001         16.001         16.001         -11.000         -11.000         -11.000         -11.001         -11.001         10.001         -11.001         -11.001         10.001         -11.001         -	135.665         1-16.71           -15.639	10.001         10.001           2         -15.665         -16.71           30         -15.959         -15.639           34         -15.108         -16.861           900         -16.095         -15.36           910         -15.601         -13.27           92         -16.09         -15.36           900         -15.601         -13.27           916         -15.576         -11.892           916         -15.576         -11.892           916         -15.576         -11.892           916         -16.344         -12.967           917         (g)         (g)         (weight 6 bars           918         -16.343         -12.967           919         (g)         (g)         (weight 6 bars           920         -16.143         -11.892           916         -11.892         -16.143           917         (g)         (weight 6 bars         Mess gain           918         (g)         (g)         (weight 6 bars           920         (g)         (g)         (weight 6 bars           920         (g)         (g)         (weight 6 bars           920
480         -15.959         -15.639         -16.861           1964         -15.108         -16.861           19000         -16.095         -15.4         -16.412           1992         -15.36         -14.015         -13.27         -16.659           30000         -15.601         -13.27         -16.659         -14.015           30000         -15.601         -13.27         -16.659         -16.143           5016         -15.576         -11.892         -16.143         -16.143           Weight 6 bars         Weight 6 bars         Mess gain         Mess gain <td>15.639         10.11           -15.108         -16.861           -15.108         -16.412           -15.36         -14.015           -13.27         -16.659           -12.967         -16.143           Veight 6 bars         Weight 6 bars         Mess gain           (g)         (g)         (%mass)         (%mass)           60°Cas         60°CAs         60°CAs         60°CAs           60°Cas         60°CAs         60°CAs         50°CAs           60°Cas         60°CAs         60°CAs         50°CAs           60°Cas         60°CAs         50°CAs         50°CAs           43.661         46.044         0.10         0.03           43.661         45.871         -0.02         0.08           43.756         45.871         0.04         0.29           43.704         45</td> <td>Image: State State</td>	15.639         10.11           -15.108         -16.861           -15.108         -16.412           -15.36         -14.015           -13.27         -16.659           -12.967         -16.143           Veight 6 bars         Weight 6 bars         Mess gain           (g)         (g)         (%mass)         (%mass)           60°Cas         60°CAs         60°CAs         60°CAs           60°Cas         60°CAs         60°CAs         50°CAs           60°Cas         60°CAs         60°CAs         50°CAs           60°Cas         60°CAs         50°CAs         50°CAs           43.661         46.044         0.10         0.03           43.661         45.871         -0.02         0.08           43.756         45.871         0.04         0.29           43.704         45	Image: State
10:00         10:00         10:00         16:661           10:00         -16:09         -15:108         -16:661           19:02         -16:09         -15:36         -14:015           30:00         -15:01         -13:27         -16:659           40:08         -16:034         -12:967         -16:199           50:16         -15:576         -11.892         -16:143           Ums         Weight 6 bars         Weight 6 bars         Weight 6 bars         Meight 6 bars         Meiss gain         Mess gain         <	No.000         -16.861           -15.008         -16.412           -15.308         -16.412           -15.306         -14.015           -13.27         -16.659           -12.967         -16.143           Vaight 6 bars         Weight 6 bars         Mess gain           10         (g)         (g)         (kmass)           67C/air         00*C/mHE:00%         23*C/air         00*C/mes)           68C/air         0.04         0.00         0.00           43.631         43.631         0.00         0.00         43.644           43.661         46.044         0.07         43.665         45.871         -0.02         0.08           43.651         45.871         -0.02         0.08         0.16         43.704           43.756         45.847         0.04         0.29         43.704         45.927         0.07         0.17           Width         Width         Width Gain         Width Gain         Width Gain         Midth Gain           9.9         9.9         0.00         0.00         0.30         9.93         9.00         0.93         9.93         9.00         9.93         9.93         9.93         9.93 <td< th=""><th>Mass pair         Mass pair         Mass pair         Mass pair           10.000         -16.095         -15.4         -16.412           100         -15.601         -13.27         -16.659           100         -15.601         -13.27         -16.659           108         -16.034         -12.967         -16.199           116         -15.576         -11.892         -16.143           116         -15.576         -11.892         -16.143           116         -15.576         -11.892         -16.143           116         -15.576         -11.892         -16.143           116         -15.576         -11.892         -16.143           116         -15.576         -11.892         -16.143           116         -15.576         -11.892         -16.143           116         -15.576         -11.892         -16.143           116         -15.576         -11.892         -16.143           116         -15.576         -11.892         -16.143           116         -15.576         -11.892         -16.143           117         -10.00         0.00         0.00           12         43.631         43.631</th></td<>	Mass pair         Mass pair         Mass pair         Mass pair           10.000         -16.095         -15.4         -16.412           100         -15.601         -13.27         -16.659           100         -15.601         -13.27         -16.659           108         -16.034         -12.967         -16.199           116         -15.576         -11.892         -16.143           116         -15.576         -11.892         -16.143           116         -15.576         -11.892         -16.143           116         -15.576         -11.892         -16.143           116         -15.576         -11.892         -16.143           116         -15.576         -11.892         -16.143           116         -15.576         -11.892         -16.143           116         -15.576         -11.892         -16.143           116         -15.576         -11.892         -16.143           116         -15.576         -11.892         -16.143           116         -15.576         -11.892         -16.143           117         -10.00         0.00         0.00           12         43.631         43.631
10:00         -16:09         -15:4         -16:412           1992         -16:99         -15:36         -14:015           3000         -15:01         -13:27         -16:659           4008         -16:034         -12:967         -16:199           5016         -15:576         -11:892         -16:143           Ums         Weight 6 bars         Weight 6 bars         Weight 6 bars         Mess gain         Mess gain           Uns         (0)         (1)         (9)         (%mess)         (%mess)         (%mess)           2002         43:631         43:631         43:631         0.00         0.00         00           72         43:649         43:644         0.10         0.03         1           480         43:674         43:661         46:044         0.07         5           1992         43:657         43:641         45:688         0.06         0.02         5           1992         43:665         43:701         45:852         0.08         0.16         6           1992         43:665         43:701         45:852         0.08         0.16         6           40008         43:662         43:756         45:84	No.00         No.00           15.4         -16.412           -15.36         -14.015           -13.27         -16.659           12.967         -16.199           -11.892         -16.143           Weight 6 bars         Mess gain           (g)         (g)           80°C/rai         80°C/FME 100%           23°C/ai         90°C/rai           80°C/rai         80°C/FME 100%           23°C/ai         90°C/rai           80°C/rai         80°C/FME 100%           23°C/ai         90°C/rai           80°C/rai         80°C/FME 100%           43.641         45.843           0.10         0.03           43.665         45.871           -0.02         0.08           43.756         45.852           0.08         0.16           43.704         45.827           0.07         0.17           9.9         9.9           9.9         9.00           0.00         0.00           9.93         10.011           0.30         0.11           9.945         9.987           0.02         0.20           9.94	No.00         16.095         16.10           100         -16.095         -16.4         -16.412           102         -16.99         -15.36         -14.015           100         -15.601         -13.27         -16.659           108         -16.034         -12.967         -16.199           116         -15.576         -11.892         -16.143           No         Weight 6 bars         Weight 6 bars         Mess gain
10.000         10.000<	10.04         10.04           15.36         .14.015           -13.27         .16.659           .12.967         .16.199           .11.892         .16.143             Weight 6 bers         Mess gain         Mess gain           (g)         (g)         (%mess)           60°C/ac         80°C/felle100%         23°C/ac         60°C/felle100%           60°C/ac         80°C/felle100%         23°C/ac         60°C/felle           43.649         45.843         0.00         0.00           43.661         46.044         0.10         0.03           43.661         46.044         0.07         43.661           43.661         46.044         0.07         43.661           43.661         46.044         0.07         43.661           43.641         45.868         0.06         0.02           43.756         45.871         -0.02         0.08           43.701         45.852         0.08         0.16           43.704         45.927         0.07         0.17           Weith         Width Gain         Width Gain         Width Gain           Width         Width Gain         0.00         0.00 <td>Mail         Mono         <th< td=""></th<></td>	Mail         Mono         Mono <th< td=""></th<>
Uma         Uma <td>10.00         110.00           -13.27         -16.659           -12.967         -16.189           -11.892         -16.143           Weight 6 bars         Mess gain         Mess gain           (g)         (%mass)         (%mass)           (g)         (%mass)         (%mass)           (g)         (%mass)         (%mass)           (g)         (%mass)         (%mass)           60*Crais         60*Crais         60*Crais           60*Crais         60*Crais         60*Crais           43.631         43.631         0.00           43.649         45.843         0.04           43.661         46.044         0.07           43.661         46.044         0.07           43.665         45.871         -0.02         0.08           43.701         45.862         0.06         0.02           43.701         45.852         0.08         0.16           43.756         45.847         0.04         0.29           43.704         45.927         0.07         0.17           Width         Width Gain         Width Gain         Width Gain           (mm)         (mm)         (%)</td> <td>Main         Most         Mass         <th< td=""></th<></td>	10.00         110.00           -13.27         -16.659           -12.967         -16.189           -11.892         -16.143           Weight 6 bars         Mess gain         Mess gain           (g)         (%mass)         (%mass)           (g)         (%mass)         (%mass)           (g)         (%mass)         (%mass)           (g)         (%mass)         (%mass)           60*Crais         60*Crais         60*Crais           60*Crais         60*Crais         60*Crais           43.631         43.631         0.00           43.649         45.843         0.04           43.661         46.044         0.07           43.661         46.044         0.07           43.665         45.871         -0.02         0.08           43.701         45.862         0.06         0.02           43.701         45.852         0.08         0.16           43.756         45.847         0.04         0.29           43.704         45.927         0.07         0.17           Width         Width Gain         Width Gain         Width Gain           (mm)         (mm)         (%)	Main         Most         Mass         Mass <th< td=""></th<>
10:001         0:001         0:001 <td>12.067         16.199           -11.892         -16.143           Weight 6 bars         Mess gain         Mess gain           (g)         (g)         (%mess)           80°C/Rike         00°C/Rike 100°K         22°C/air         60°C/Rike           80°C/Rike         00°C/Rike 100°K         22°C/air         60°C/Rike           80°C/Rike         00°K         22°C/air         60°C/Rike           80°C/Rike         0.00         0.00         143.631         0.00         0.00           43.644         0.10         0.03         43.644         0.07         143.655         45.871         -0.02         0.08           43.651         45.871         -0.02         0.08         143.756         45.852         0.08         0.16           43.756         45.852         0.08         0.16         143.756         45.827         0.07         0.17           Width         Width Gain         Width Gain         Width Gain         17           Width         Width Gain         Width Gain         Width Gain         16           9.9         9.9         0.00         0.00         117         17           Width         Width Gain         0.11         0.33<!--</td--><td>No.         No.00         10.00         10.000           16.034         -12.967         -16.199         -16.143           116         -15.576         -11.892         -16.143           no         Weight 6 bars         Weight 6 bars         Mess gain         Mess gain           (g)         (g)         (g)         (g)         (g)           227/Car         60*Crac         60*Crac         60*Crac         90*Crac           0         43.631         43.631         0.00         0.00         0.00           22         43.649         45.843         0.04         5.07         5.07           80         43.661         46.044         0.07         5.53         100         43.624         43.665         45.871         -0.02         0.08         5.13           100         43.624         43.665         45.871         -0.02         0.08         5.13</td></td>	12.067         16.199           -11.892         -16.143           Weight 6 bars         Mess gain         Mess gain           (g)         (g)         (%mess)           80°C/Rike         00°C/Rike 100°K         22°C/air         60°C/Rike           80°C/Rike         00°C/Rike 100°K         22°C/air         60°C/Rike           80°C/Rike         00°K         22°C/air         60°C/Rike           80°C/Rike         0.00         0.00         143.631         0.00         0.00           43.644         0.10         0.03         43.644         0.07         143.655         45.871         -0.02         0.08           43.651         45.871         -0.02         0.08         143.756         45.852         0.08         0.16           43.756         45.852         0.08         0.16         143.756         45.827         0.07         0.17           Width         Width Gain         Width Gain         Width Gain         17           Width         Width Gain         Width Gain         Width Gain         16           9.9         9.9         0.00         0.00         117         17           Width         Width Gain         0.11         0.33 </td <td>No.         No.00         10.00         10.000           16.034         -12.967         -16.199         -16.143           116         -15.576         -11.892         -16.143           no         Weight 6 bars         Weight 6 bars         Mess gain         Mess gain           (g)         (g)         (g)         (g)         (g)           227/Car         60*Crac         60*Crac         60*Crac         90*Crac           0         43.631         43.631         0.00         0.00         0.00           22         43.649         45.843         0.04         5.07         5.07           80         43.661         46.044         0.07         5.53         100         43.624         43.665         45.871         -0.02         0.08         5.13           100         43.624         43.665         45.871         -0.02         0.08         5.13</td>	No.         No.00         10.00         10.000           16.034         -12.967         -16.199         -16.143           116         -15.576         -11.892         -16.143           no         Weight 6 bars         Weight 6 bars         Mess gain         Mess gain           (g)         (g)         (g)         (g)         (g)           227/Car         60*Crac         60*Crac         60*Crac         90*Crac           0         43.631         43.631         0.00         0.00         0.00           22         43.649         45.843         0.04         5.07         5.07           80         43.661         46.044         0.07         5.53         100         43.624         43.665         45.871         -0.02         0.08         5.13           100         43.624         43.665         45.871         -0.02         0.08         5.13
Store         15.007         12.007         12.007         10.102           SO16         -15.576         -11.892         -16.143           Imo         Weight 6 bars         Weight 6 bars         Weight 6 bars         Mess pain         Mess pai	Name         Name <th< td=""><td>No.001         Lossi         Horse           116         -15.576         -11.892         -16.143           10         10         10         10           10         10         10         10           10         10         10         10           10         10         10         10           10         10         10         10           10         10         10         10           10         10         10         10           10         10         10         10           10         10         10         10           10         10         10         10           10         10         10         10           116         143.631         43.631         0.00           100         43.674         43.644         0.10         0.03           100         43.674         43.644         0.10         0.03         10           101         43.661         46.044         0.07         5.53         10           100         43.624         43.665         45.871         -0.02         0.08         5.13           100&lt;</td></th<>	No.001         Lossi         Horse           116         -15.576         -11.892         -16.143           10         10         10         10           10         10         10         10           10         10         10         10           10         10         10         10           10         10         10         10           10         10         10         10           10         10         10         10           10         10         10         10           10         10         10         10           10         10         10         10           10         10         10         10           116         143.631         43.631         0.00           100         43.674         43.644         0.10         0.03           100         43.674         43.644         0.10         0.03         10           101         43.661         46.044         0.07         5.53         10           100         43.624         43.665         45.871         -0.02         0.08         5.13           100<
time         Weight 6 bers         Weight 6 bers         Mess gain	Weight 6 bars         Mess gain         Mess gain           (g)         (g)         (%mess)         (%mess)           80°C/as         80°C/ME100%         23°C/as         60°C/mes)           43.631         43.631         0.00         0.00           43.649         45.843         0.04         43.644           43.651         46.044         0.07         43.665           43.661         46.044         0.07         43.665           43.641         45.868         0.06         0.02           43.756         45.871         -0.02         0.08           43.756         45.871         0.04         0.29           43.764         45.852         0.08         0.16           43.756         45.847         0.04         0.29           43.704         45.927         0.07         0.17           Width         Width Gain         Width Gain         Width Gain           Width         Width Gain         Width Gain         0.00           9.9         9.9         0.00         0.00         9.903           9.91         0.11         0.33         9.945         9.987           9.945         9.987         0.45	No.00         Weight 6 Dars         Weight 6 Dars         Weight 6 Dars         Mess gain
Uma         Weight 6 bars         Weight 6 bars         Weight 6 bars         Mass gain         Qumass)         QYumass)         QYumass in a constraint of the constrant of the constraint of the constraint of the constrain	Weight 6 bars         Weight 6 bars         Miss gain         Miss gain           (g)         (g)         (%mass)         (%mass)           (g)         (%mass)         (%mass)         (%mass)           60*Crait         60*Crait         60*Crait         60*Crait         6           43.631         43.631         0.00         0.00         4           43.649         45.843         0.04         4           43.661         46.044         0.07         4           43.661         46.044         0.07         4           43.661         46.044         0.07         4           43.661         45.871         -0.02         0.08           43.701         45.852         0.08         0.16           43.756         45.847         0.04         0.29           43.704         45.927         0.07         0.17           Width         Width Gain         Width Gain         Width Gain           (mm)         (mm)         (%)         1%)         6%           9.93         10.011         0.30         9.93         9.93           9.933         10.11         0.033         9.945         9.987         0.45 </th <th>Weight 6 bars         Weight 6 bars         Mess gain         Mess gain</th>	Weight 6 bars         Weight 6 bars         Mess gain
Tims         Weight 6 bers         Weight 6 bers         Weight 6 bers         Mess gen         Mess gen </td <td>Weight 6 Date         Mess gain         Mess gain         Mess gain           (g)         (g)         (%mass)         (%mass)           80°C/air         80°C/BiNE 100%         23°C/air         80°C/air           43.631         43.631         0.00         0.00           43.649         45.843         0.10         0.03           43.644         0.10         0.03         43.665           43.651         46.044         0.07         43.665           43.665         45.871         -0.02         0.08           43.701         45.852         0.08         0.16           43.756         45.847         0.04         0.29           43.704         45.927         0.07         0.17           Width         Width Oain         Width Gain         Width Gain           Width         Width Oain         Width Gain         9.9           9.9         9.9         0.00         0.00         9.9           9.93         10.011         0.33         9.93         9.93           9.93         0.11         0.03         9.93         9.94         9.94           9.945         9.987         0.45         9.915         9.920</td> <td>Weight 6 bars         Weight 6 bars         Mess gan         Mess gan</td>	Weight 6 Date         Mess gain         Mess gain         Mess gain           (g)         (g)         (%mass)         (%mass)           80°C/air         80°C/BiNE 100%         23°C/air         80°C/air           43.631         43.631         0.00         0.00           43.649         45.843         0.10         0.03           43.644         0.10         0.03         43.665           43.651         46.044         0.07         43.665           43.665         45.871         -0.02         0.08           43.701         45.852         0.08         0.16           43.756         45.847         0.04         0.29           43.704         45.927         0.07         0.17           Width         Width Oain         Width Gain         Width Gain           Width         Width Oain         Width Gain         9.9           9.9         9.9         0.00         0.00         9.9           9.93         10.011         0.33         9.93         9.93           9.93         0.11         0.03         9.93         9.94         9.94           9.945         9.987         0.45         9.915         9.920	Weight 6 bars         Weight 6 bars         Mess gan
(r)         (g)         (g)         (vmmas)         (vs)         (vs)	Igl         (g)         (Vernest)         (Vernest)           60°C/air         80°C/RME100%         23°C/air         80°C/nit         80°C/nit           43.643         43.643         0.00         0.00         43.644           43.644         0.10         0.03         43.644         0.077           43.661         46.044         0.07         43.665         45.871         -0.02         0.08           43.701         45.858         0.06         0.02         43.701         45.852         0.08         0.16           43.756         45.847         0.04         0.29         43.704         45.927         0.07         0.17           Width         Width         Width Gain         Width Gain         Width Gain         Midth Gain           Width         Width         Width Gain         Midth Gain         Midth Gain         9.9           9.9         9.9         0.00         0.00         9.00         9.00         9.00         9.00           9.93         10.011         0.30         9.9.9         9.00         0.45         9.88         9.88         9.20         -0.20         -0.20         9.20         9.20         9.20         9.20         9.20         9	(j)         (j)         (j)         (vmss)         (%mss)
22°C/air         60°C/air         60°C/RME107%         22°C/air         60°C/mic         80°C/mic           0         43.631         43.631         43.631         0.00         0.00         0           72         43.649         45.843         0.00         0.04         5           480         43.671         43.649         45.843         0.04         5           480         43.674         43.644         0.10         0.03         5           984         43.665         45.871         -0.02         0.08         5           1992         43.657         43.641         45.868         0.06         0.02         5           1992         43.655         43.701         45.852         0.08         0.16         5           3000         43.665         43.704         45.927         0.07         0.17         5           5016         43.662         43.756         45.927         0.07         0.17         5           Width         Width Cain         Width Cain         Width Cain         Width Cain         Width Cain           0         mm         (mm)         (mm)         (%)         (%)         5         5 <td>BOTCHALE 107X         23*C/ai         BOTCHALE 107X           43.631         43.631         0.00         0.00           43.649         45.843         0.04         43.641           43.649         45.843         0.04         43.641           43.661         46.044         0.07         43.665           43.641         45.868         0.06         0.02           43.641         45.868         0.06         0.02           43.701         45.852         0.08         0.16           43.756         45.847         0.04         0.29           43.704         45.827         0.07         0.17           Width         Width Gain         Width Gain         Width Gain           Width         Width Gain         Width Gain         0.00           9.93         10.011         0.30         9.993           9.945         9.987         0.45         9.88           9.945         9.987         0.45         9.985           9.945         9.988         0.20         0.06</td> <td>28°C/air         SevCrair         80°C/RME 100%         23°C/air         80°C/RME           0         43.631         43.631         0.00         0.00         0.00           /2         43.649         45.843         0.04         5.07           80         43.674         43.644         0.10         0.03           84         43.661         46.044         0.07         5.53           90         43.624         43.665         45.871         -0.02         0.08         5.13           90         43.627         43.665         45.871         -0.02         0.07         5.53</td>	BOTCHALE 107X         23*C/ai         BOTCHALE 107X           43.631         43.631         0.00         0.00           43.649         45.843         0.04         43.641           43.649         45.843         0.04         43.641           43.661         46.044         0.07         43.665           43.641         45.868         0.06         0.02           43.641         45.868         0.06         0.02           43.701         45.852         0.08         0.16           43.756         45.847         0.04         0.29           43.704         45.827         0.07         0.17           Width         Width Gain         Width Gain         Width Gain           Width         Width Gain         Width Gain         0.00           9.93         10.011         0.30         9.993           9.945         9.987         0.45         9.88           9.945         9.987         0.45         9.985           9.945         9.988         0.20         0.06	28°C/air         SevCrair         80°C/RME 100%         23°C/air         80°C/RME           0         43.631         43.631         0.00         0.00         0.00           /2         43.649         45.843         0.04         5.07           80         43.674         43.644         0.10         0.03           84         43.661         46.044         0.07         5.53           90         43.624         43.665         45.871         -0.02         0.08         5.13           90         43.627         43.665         45.871         -0.02         0.07         5.53
0         43.631         43.631         43.631         0.00         0.00         0.00           72.         43.649         45.843         0.04         9           480         43.674         43.644         0.10         0.03           984         43.661         46.044         0.07         9           1000         43.624         43.665         45.871         -0.02         0.08         9           1992         43.657         43.641         45.868         0.06         0.02         9           1992         43.655         45.871         -0.02         0.08         9         9           3000         43.665         43.701         45.852         0.08         0.16         9           4008         43.649         43.756         45.847         0.04         0.29         6           5016         43.662         43.704         45.927         0.07         0.17         5	43.631         43.631         0.00         0.00           43.649         45.843         0.04	0         43.631         43.631         43.631         0.00         0.00         0.00           2         43.649         45.843         0.04         5.07           80         43.674         43.644         0.10         0.03           84         43.661         46.044         0.07         5.53           900         43.624         43.665         45.871         -0.02         0.08         5.13           900         43.624         43.665         45.871         -0.02         0.08         5.13
72         43.649         45.843         0.04         5           480         43.674         43.644         0.10         0.03         984           984         43.661         46.044         0.07         5           1000         43.624         43.661         46.044         0.07         5           1992         43.657         43.641         45.868         0.06         0.02         5           1992         43.657         43.641         45.868         0.06         0.02         5           3000         43.665         43.701         45.852         0.08         0.16         5           4008         43.649         43.756         45.847         0.04         0.29         5           5016         43.662         43.704         45.927         0.07         0.17         5           Units         With With With Gain< With Gain	43.649         45.843         0.04           43.644         0.10         0.03           43.661         46.044         0.07           43.665         45.671         -0.02         0.08           43.641         45.668         0.06         0.02           43.701         45.852         0.08         0.16           43.704         45.927         0.07         0.17           45.756         45.847         0.04         0.29           43.704         45.927         0.07         0.17           Width         Width Gain           Width         Width Gain         Width Gain           9.9         9.9         0.00         0.00           9.93         10.011         0.30         9.93           9.945         9.987         0.04         0.30           9.945         9.987         0.45         9.88           9.915         10.002         0.16         0.15           9.908         -0.20         0.20         0.20	12         43.649         45.843         0.04         5.07           80         43.674         43.644         0.10         0.03         3           84         43.661         46.044         0.07         5.53         3           90         43.624         43.665         45.871         -0.02         0.08         5.13           90         45.627         43.665         45.871         -0.02         0.08         5.13
#80         43.674         43.644         0.10         0.03           984         43.661         46.044         0.07         9           1000         43.624         43.665         45.871         -0.02         0.08         9           1000         43.624         43.665         45.871         -0.02         0.08         9           1992         43.657         43.641         45.868         0.06         0.02         9           3000         43.665         43.701         45.852         0.08         0.16         6           4008         43.649         43.756         45.847         0.04         0.29         9           5016         43.662         43.704         45.927         0.07         0.17         5           Umme         Width         Width         Width         Width         0.07         0.17         5           Umme         Width         Width         Width         Width         Width         0.07         0.17         5           Umme         Width         Width         Width         Width         Width         0.07         0.17         5           Umme	43.644         0.10         0.03           43.661         46.044         0.07           43.661         46.044         0.07           43.661         45.871         -0.02         0.08           43.641         45.868         0.06         0.02           43.701         45.868         0.06         0.02           43.701         45.852         0.08         0.16           43.756         45.847         0.04         0.29           43.704         45.927         0.07         0.17	80         43.674         43.644         0.10         0.03           84         43.661         46.044         0.07         5.53           900         43.624         43.665         45.871         -0.02         0.08         5.13           900         43.627         43.665         45.871         -0.02         0.08         5.13
984         43.661         46.044         0.07         1           1000         43.624         43.665         45.871         -0.02         0.08         1           1992         43.657         43.641         45.868         0.06         0.02         6           3000         43.655         43.701         45.852         0.08         0.16         6           4008         43.649         43.756         45.847         0.04         0.29         6           4008         43.662         43.704         45.927         0.07         0.17         5           5018         43.662         43.704         45.927         0.07         0.17         5           Width         Width Gain         Gain	43.661         46.044         0.07           43.665         45.871         -0.02         0.08           43.641         45.868         0.06         0.02           43.701         45.868         0.06         0.02           43.701         45.868         0.06         0.02           43.701         45.852         0.08         0.16           43.704         45.852         0.07         0.17           43.704         45.827         0.07         0.17           Width         Width Gain         Width Gain         Width Gain           Width         Width Gain         Width Gain         Width Gain           B07Craix         807Craix         80°Craix         80°Craix           9.93         10.011         0.30         9.903           9.93         0.11         0.03         9.903           9.945         9.987         0.45         9.88           9.905         0.16         0.15         9.906           9.908         -0.20         -0.20         -0.20	84         43.661         46.044         0.07         5.53           900         43.624         43.665         45.871         -0.02         0.08         5.13           900         45.627         45.627         0.02         0.08         5.13
1000         43.624         43.665         45.871         -0.02         0.08         1           1992         43.657         43.641         45.858         0.06         0.02         1           3000         43.665         43.701         45.852         0.08         0.16         1           3000         43.649         43.756         45.847         0.04         0.29         6           4008         43.649         43.756         45.847         0.04         0.29         6           5016         43.662         43.704         45.927         0.07         0.17         5           Ume         Width         Width         Width Gain         Width Gain         Width Gain         Width Gain           Ima         Width         Width         Width Gain	43.665         45.871         -0.02         0.08           43.641         45.868         0.06         0.02           43.701         45.852         0.08         0.16           43.704         45.852         0.04         0.29           43.704         45.927         0.07         0.17           Width         Width Gain         Width Gain         Width Gain           Width         Width Gain         Width Gain         Width Gain           Width         Width Gain         Width Gain         Width Gain           BerCane         607C/Bit Ellors         23°Clair         60°C/Bit           9.9         9.9         0.00         0.00         9.30           9.933         10.011         0.330         9.945         9.987           9.945         9.987         0.45         9.88         10.009         -0.20         0.20           9.915         10.002         0.16         0.15         9.906         9.988         -0.20         0.06	XXX         43.665         45.871         -0.02         0.08         5.13           XXX         43.665         45.871         -0.02         0.08         5.13
1992         43.657         43.641         45.868         0.06         0.02         5           3000         43.665         43.701         45.852         0.08         0.16         6           4008         43.649         43.756         45.847         0.04         0.29         5           5016         43.662         43.704         45.927         0.07         0.17         5           time         With         With         With Gain         With Gain         With Gain         With Gain           (h)         (mn)         (mn)         (mn)         (%)         (%)         (%)         (%)         (%)         (%)	43.641         45.868         0.06         0.02           43.701         45.852         0.08         0.16           43.756         45.847         0.04         0.29           43.704         45.927         0.07         0.17           Width         Width Gain         Width Gain         Width Gain           Width         Width Gain         Width Gain         Width Gain           SerClair         80°C/ark         80°C/ark         60°C/ark           9.9         9.9         0.00         0.00           9.93         10.011         0.30         9.933           9.945         9.987         0.45         9.88           9.88         10.009         -0.20         -0.20           9.915         10.002         0.16         0.15           9.908         9.988         -0.20         0.06	
3000         43.665         43.701         45.852         0.08         0.16         43.665           4008         43.649         43.756         45.847         0.04         0.29         45.957           5016         43.662         43.704         45.927         0.07         0.17         5           Imme         Width         Width         Width         Gain         Width         Width           01         fmm         (mm)         (mm)         (%)         (%)         (%)           01         fmm         Gain         Width         Width </td <td>43.701         45.852         0.08         0.16           43.756         45.847         0.04         0.29           43.704         45.827         0.07         0.17           Width         Width Gain         Width Gain         Width Gain           (mm)         (mm)         (%)         (%)           ecrclair         80727845100%         22°Clair         60°Clair           9.9         9.9         0.00         0.00           9.933         10.011         0.30           9.903         0.11         0.03           9.945         9.987         0.45           9.88         10.009         -0.20         -0.20           9.915         10.002         0.16         0.15           9.908         -0.20         0.06         0.08</td> <td><b>17/2 43.65/ 43.641 45.868 0.06 0.02 5.13</b></td>	43.701         45.852         0.08         0.16           43.756         45.847         0.04         0.29           43.704         45.827         0.07         0.17           Width         Width Gain         Width Gain         Width Gain           (mm)         (mm)         (%)         (%)           ecrclair         80727845100%         22°Clair         60°Clair           9.9         9.9         0.00         0.00           9.933         10.011         0.30           9.903         0.11         0.03           9.945         9.987         0.45           9.88         10.009         -0.20         -0.20           9.915         10.002         0.16         0.15           9.908         -0.20         0.06         0.08	<b>17/2 43.65/ 43.641 45.868 0.06 0.02 5.13</b>
4008         43.649         43.756         45.847         0.04         0.29         1           5016         43.662         43.704         45.927         0.07         0.17         1           Ima         Width         Width         Width Gain         Width Ga	43.756         45.847         0.04         0.29           43.704         45.927         0.07         0.17           Width         Width Gain         Width Gain           (mm)         (mm)         (%)         1%)           B07C0Ak         807C7AkE100%         23*Clair         60*Crair           9.9         9.9         0.00         0.00           9.93         10.011         0.30         9.903           9.945         9.987         0.45         9.88           9.009         -0.20         -0.20         9.915           9.908         9.988         -0.20         0.06	<b>200</b> 43.665 43.701 45.852 0.08 0.16 5.09
5018         43.662         43.704         45.927         0.07         0.17         1           Line         Width         Width         Width         Width Gain	43.704         45.927         0.07         0.17           Width         Width         Width Gain         Width Gain         Width Gain           (mm)         (mm)         (%)         %)         %)           B0*Clair         60*Clair         60*Clair         60*Clair         60*Clair           9.9         9.9         0.00         0.00         9.93           9.93         10.011         0.30         9.945           9.945         9.987         0.45         9.88           9.88         10.009         -0.20         -0.20           9.915         10.002         0.16         0.15           9.908         -0.20         0.08         9.988	308 43,649 43,756 45,847 0.04 0.29 5.08
Ume         Width         Width Gain	Width         Width Gain         Width Gain           (mm)         (mm)         (%)         1%)           B0°Clair         80°Clair         80°Clair         80°Clair           9.9         9.9         0.00         0.00           9.93         10.011         0.30           9.903         0.11         0.03           9.945         9.987         0.45           9.88         10.009         -0.20         -0.20           9.915         10.002         0.16         0.15           9.908         9.988         -0.20         0.06	16 43.662 43.704 45.927 0.07 0.17 5.26
Ume With With With Gain Group Gain Gain Gain Gain Gain Gain Gain Gain	Width         Width Gain         Width Gain           (mm)         (mm)         (%)         (%)           derClair         80°C784£100%         22°C/air         60°C784           9.9         9.9         0.00         0.00           9.933         10.011         0.30           9.903         0.11         0.03           9.945         9.987         0.45           9.88         10.009         -0.20         -0.20           9.915         10.002         0.16         0.15           9.908         9.988         -0.20         0.06	Hellow
Ume         Width         Width         Width         Width Gain         W	Width         Width Oain         Width Gain           (mm)         (mm)         (%)         (%)           B0*Ckair         60*Ck7RNE500%         23*Ckair         60*Ck7RNE500%           9.9         9.9         0.00         0.00           9.93         10.011         0.30           9.903         0.11         0.03           9.945         9.987         0.45           9.88         10.009         -0.20         -0.20           9.915         10.002         0.16         0.15           9.908         -0.20         0.06	
(h)         (mm)         (%)         (%)           23*Clar         50*Clar         50*Clar         60*Clar         60*Clar	(mm)         (%)         %)           ecrCase         sortCRME100%         23*Clair         60*Clair         60           9.9         9.9         0.00         0.00         9.93         0.00         0.00           9.93         10.011         0.30         9.93         0.11         0.03         9.945         9.987         0.45         9.88         10.009         -0.20         -0.20         9.915         10.002         0.16         0.15         9.908         9.988         -0.20         0.08         9.985         10.02         0.16         0.15         10.02         0.06         0.985         10.02         0.06         0.08         10.02         0.16         0.15         10.02         0.06         0.08         10.02         0.16         0.15         10.02         0.06         0.08         10.02         0.06         0.08         10.02         0.06         0.08         10.02         0.06         0.08         10.02         0.06         10.08         10.02         0.06         15         10.02         0.06         10.08         10.02         10.02         10.06         10.02         10.08         10.02         10.08         10.02         10.06         10.02         10.08	me Width Width Width Gain Width Gain Width Gain
23*Crist 80*Crist 80*C/RME100% 23*Crist 80*Crist 80*Crist	B0*Clast         50*Clast         50*Clast         60*Clast         60*Clast         60           9.9         9.9         0.00         0.00         0.00         9.93         10.011         0.30         9.933         0.011         0.30         9.933         9.933         0.011         0.30         9.903         9.915         0.11         0.03         9.945         9.987         0.45         9.915         10.002         0.16         0.15         9.906         9.998         -0.20         -0.20         9.906         9.988         -0.20         0.06         0.15         9.906         9.988         -0.20         0.06         0.08         10.002         0.16         0.15         10.002         0.06         0.08         10.002         0.06         10.002         0.06         10.002         0.06         10.002         0.06         10.002         0.06         10.002         10.06         10.002         10.06         10.002         10.06         10.05         10.002         10.06         10.02         10.06         15         10.002         10.06         10.06         10.06         10.06         10.06         10.06         10.06         10.06         10.06         10.06         10.06         10.06         10.06 <th>(non) (non) (75)</th>	(non) (non) (75)
1000000000	9.9         9.9         0.00         0.00           9.93         10.011         0.30	COTORNEL COTOR
<b>0</b> 9.9 9.9 9.9 0.00 0.00	9.93         10.011         0.30           9.903         0.11         0.03           9.945         9.987         0.45           9.88         10.009         -0.20         -0.20           9.915         10.002         0.16         0.15           9.908         -0.20         0.06         -0.86	<b>0</b> 9.9 9.9 9.9 0.00 0.00 0.00
9.93 10.011 0.30 1	9.903         0.11         0.03           9.945         9.987         0.45           9.88         10.009         -0.20         -0.20           9.915         10.002         0.16         0.15           9.908         9.988         -0.20         0.08	9.93 10.011 0.30 1.12
<b>480</b> 9.911 9.903 0.11 0.03	9.945         9.987         0.45           9.88         10.009         -0.20         -0.20           9.915         10.002         0.16         0.15           9.908         9.988         -0.20         0.08	80 9.911 9.903 0.11 0.03
984 9.945 9.987 0.45 0	9.88         10.009         -0.20         -0.20           9.915         10.002         0.16         0.15           9.908         9.988         -0.20         0.06	9.945 9.987 0.45 0.88
1000 9.88 9.88 10.009 -0.20 -0.20	9.915 10.002 0.16 0.15 9.908 9.988 -0.20 0.08	00 9.88 9.88 10.009 -0.20 -0.20 1.10
<b>1992</b> 9.916 9.915 10.002 0.16 0.15	9.908 9.988 -0.20 0.08	92 9.916 9.915 10.002 0.16 0.15 1.03
<b>3000</b> 9.88 9.908 9.988 -0.20 0.08 (		9.88 9.908 9.988 -0.20 0.08 0.89
4008 9.867 9.883 9.976 -0.33 -0.17 (	9.883 9.976 -0.33 -0.17	9.867 9.883 9.976 -0.33 -0.17 0.77
5016 9.884 9.886 9.988 -0.16 -0.14 (	9.886 9.988 -0.16 -0.14	9.884 9.886 9.988 -0.16 -0.14 0.89
time Thickness Thickness Thickness Gain Thickness Gain Thick		me Thickness Thickness Thickness Cain Thickness Cain Thickness
(h) (mm) (mm) (%)	Thickness Thickness Gain Thickness Gain 3	(h) (mm) (mm) (%) (%) (%)
23°C/air 60°C/air 60°C/Air 60°C/Air 60°C/air 60°C/air 60°C/air	Tholoness Thiolones Thiolones Gain Thiolones Gain 3 (mm) (mm) (%) (%)	23°C/air 80°C/BME 100% 23°C/air 80°C/BME
	Thickness Thickness Gain Thickness Gain (%) (%) (%) (%) (%) (%) (%) (%) (%) (%)	0 3.851 3.851 3.851 0.00 0.00 0.00
3.851 3.851 0.00 0.00	Thickness         Thickness <ththickness< th=""> <ththickness< th=""> <tht< td=""><td>3849 3914 -0.05 164</td></tht<></ththickness<></ththickness<>	3849 3914 -0.05 164
0         3.851         3.851         0.00         0.00         0           72         3.849         3.914         -0.05         -         -	Thickness         Thickness         Thickness         Gain	0.010 1 0.011
00         3.851         3.851         3.851         0.00         0.00         0           7/2         3.849         3.914         -0.05         -	Thickness         Thickness         Thickness Gain         Thickness Gain <ththickness gain<="" th="">         Thickness Gain<td>80 3.867 3.847 0.42 -0.10</td></ththickness>	80 3.867 3.847 0.42 -0.10
0         3.851         3.851         3.851         0.00         0.00         0           72         3.849         3.914         -0.05         3         <	Thickness         Thickness Gain         Thickness Ga	S0         3.867         3.847         0.42         -0.10           84         3.816         3.916         -0.91         1.69
0         3.851         3.851         3.851         0.00         0.00         0           72         3.849         3.914         -0.05         -         <	Thickness         Thickness         Thickness         Call         Thickness         Gain         Gain <t< td=""><td>State         State         <th< td=""></th<></td></t<>	State         State <th< td=""></th<>
00         3.851         3.851         0.00         0.00         0           72         3.849         3.914         -0.05	Thickness         Thickness         Thickness Gain         Thickness Gain           (mm)         (%)         (%)         (%)           80°C/RME100%         23°C/air         80°C/RME100%         23°C/air           3.851         3.851         0.00         0.00           3.849         3.914         -0.05         3.847           3.816         3.916         -0.91           3.852         3.911         -0.21         0.03           3.845         3.912         -0.18         -0.16	80         3.867         3.647         0.42         -0.10           184         3.816         3.916         -0.91         1.69           000         3.843         3.852         3.911         -0.21         0.03         1.56           992         3.844         3.845         3.912         -0.18         -0.16         1.58
0.00         3.851         3.851         3.851         0.00         0.00         0           72         3.849         3.914         -0.05	Thickness         Thickness         Thickness Gain         Thickness Gain           (mm)         (mm)         (%)         (%)         (%)           80*CVAie         60°CVAie         50°CVaie         50°CVaie         50°CVaie           3.851         3.851         0.00         0.00         3.849           3.849         3.914         -0.05         3.847           3.816         3.916         -0.91         3.852           3.852         3.911         -0.21         0.03           3.845         3.912         -0.18         -0.16           3.855         3.92         -0.16         0.10	80         3.867         3.847         0.42         -0.10           184         3.816         3.916         -0.91         1.69           184         3.843         3.852         3.911         -0.21         0.03         1.56           192         3.844         3.845         3.912         -0.18         -0.16         1.56           192         3.845         3.855         3.92         -0.16         1.57
0         3.851         3.851         3.851         0.00         0.00         0           72         3.849         3.914         -0.05	Thickness         Thickness         Thickness         Thickness         Gain         G	80         3.867         3.847         0.42         -0.10           84         3.816         3.916         -0.91         1.69           900         3.843         3.852         3.911         -0.21         0.03         1.56           992         3.844         3.845         3.912         -0.18         -0.16         1.58           900         3.845         3.855         3.92         -0.16         0.10         1.79           908         3.851         3.852         3.907         0.000         0.03         1.45
0         3.851         3.851         3.851         0.00         0.00         0           72         3.849         3.914         -0.05         -0.010         -0.05         -0.010         -0.05         -0.016         -0.016         -0.016         -0.016         -0.016         -0.016         -0.02         -0.02         -0.02         -0.03         -0.02         -0.03         -0.02         -0.03         -0.02         -0.03         -0.02         -0.02         -0.02         -0.02         -0.02 <td>Thickness         Thickness         Thickness         Thickness         Gain         Thickness         Gain         Thickness         Gain         Thickness         Gain         Thickness         Gain         Thickness         Gain         Stress         Stress</td> <td>80         3.867         3.647         0.42         -0.10           184         3.816         3.916         -0.91         1.69           000         3.843         3.852         3.911         -0.21         0.03         1.66           920         3.844         3.845         3.912         -0.18         -0.16         1.58           000         3.845         3.855         3.92         -0.16         0.10         1.79           008         3.851         3.852         3.907         0.00         0.03         1.45           016         3.844         3.857         3.928         -0.18         0.16         0.53         1.45</td>	Thickness         Thickness         Thickness         Thickness         Gain         Thickness         Gain         Thickness         Gain         Thickness         Gain         Thickness         Gain         Thickness         Gain         Stress	80         3.867         3.647         0.42         -0.10           184         3.816         3.916         -0.91         1.69           000         3.843         3.852         3.911         -0.21         0.03         1.66           920         3.844         3.845         3.912         -0.18         -0.16         1.58           000         3.845         3.855         3.92         -0.16         0.10         1.79           008         3.851         3.852         3.907         0.00         0.03         1.45           016         3.844         3.857         3.928         -0.18         0.16         0.53         1.45

CONFIDENTIAL

## Appendix 1

## Moulding details

Polymer	Unit	CARILON RDP 205	PA12	HDPE Lupolen 5021D Q425
Date		05-07-96	08-02-96	05-07-96
Barrel Temperatures				
Nose	°C	260	265	255
Zone1	°C	260	270	255
zone2	°C	250	250	245
zone3	°C	220	235	235
Mould temperatures				
Mould 1	°C	70	60	40
Mould 2	°C	70	60	40
Injection speed	%	50	50	70
Holding Pressure		45	38	60
Holding time	s	14	18	35
Cool time	s	5	8	5
Cycle time	S	25	32	47

Appendix 2A

## Set up of the ageing programme for RDP 205

# AGEING PROGRAMMES FOR POLYMERS

Project name of identification	Effect of RME 100% and diesel/RME 85/15 % vol/vol on the performance of CARILON Polymer

## MATERIALS

Code	Identification	Batch	Date inj. moulding
P1	RDP205	MDU96/008	22-04-96

## MEDIA AND TEMPERATURES

Code	Medium	Temp. Comments/composition
M1	RME 100%	80 See LJ CAR2/118/96 addendum no 2
M2	RME 15% in diesel	80 See LJ CAR2/118/96 addendum no 2
M3	AIR	80 Effect of temperature on the behaviour of polymer
M4	AIR	23 Reference condition, RH 50%.

## AGING TIMES AND DATES OF TESTING

Time	Time	Days	Hours	Date of	Time	Time	Days	Hours	Date of
Code	hours			testing	Code	hours			testing
A0	0	0	0	07-03-96	A0	0	0	0	14-06-96
A1	192	8	0	15-03-96					
A2	480	20	0	27-03-96					
A3	864	36	0	12-04-96					
A4	2856	119	0	04-07-96					
A5	2976	124	0	09-07-96					
A6	4152	173	0	27-08-96					
A7	3000				A7	3096	129	0	21-10-96
A8	3984				A8	4008	167	0	28-11-96
A9	4992				A9	5016	209	0	09-01-97

#### MONITORING TESTS

Test code	Description	Standard	Specimen	Temp. of	Monitoring properties		
		method	Туре	test °C			
T1	Tensile properties	ISO527	Dumbbell	23	Mod, Yld, Brk, (stress/strain)		
T2	Dimensional change	LJ11896	Dumbbell	23	Thickness and width change		
ТЗ	Mass change	LJ11896	Dumbbell	23	Mass change		
Τ4	Yellowness	DIN6167	Dumbbell	23	Yellowness change		
T5	Volatiles		Dumbbell	23	Volatiles change		

Appendix 2B

Set up of the ageing programme for RDP 205

Details of the starting of	f the ageing t	<u>est on 140696</u>
Details of RME used for testin	a: Supplie	r: NOVAOL
Drum, 5L contents according	to the label.	
Drum code: Bef 5248	datum:	15-04-97
	dutum	
Filling of cylinders with RME		
Cylinder code:	Volume Material	Level, %
113	380 RME	100
114	380 RME/Die	esel 15
Mixing of only and diago		
	0	
	9 72 1	
	202.0	
Diesel 420	15 47	
	15.47	
Remarks: The liquids are	shaked well in ar	erlenmeier for about 3 minutes at RT
Date:		06-14-96
Time of placement in ovens a	t 60 °C:	10:30
Oven codes:		
material	Oven	
MDU96/008	6	
Procedure for the remo	val of specim	ens from the cylinders
Cylinders were withdrawn fror	n the oven and a	lowed to cool for about 30 min. before opening.
It was observed that by only w	iping of the tensi	le bars from the RME in the cylinders
the surface was fatty and see	ned to have a glo	ossy appearance.
Therefore it was tested wheth	er the specimens	could be cleaned better by rinsing with a solvent.
From earlier experiments it wa	as found that tolu	ene is a good solvent for RME.
Therefore all specimens teste	d were dipped in	toluene and stirred
for about 5 seconds in a cyline	ler with about 30	0 ml toluene .
Immediately thereafter the spe	ecimens were dri	ed with a clean cloth.
Immediately after drying the n	nass of each set	of 6 specimens was determined.
The specimens were tested for	r the mechanical	properties and the yellowness within 3 hours
after removal from the cylinde	ers.	

## Appendix 2C

# Ageing programme for RDP 205, specimens arrangement

AGEIN	<u>G</u> PR(	OGRAM	MES F	OR PO	LYMER	<u> 35</u>								
Project:		Effect of R	ME on the	performan	ce of CARI	LON Polyn	ner							
	l	T		l		1	ſ							
Summary	of specime	98 60068												
MATERIA	LS	Time	Date	MEDIA	TEMP	RH	Oven nr	CYL/TRAY	5 <b>-</b> 9	imen	nrs			
Code	Туре	hours			°C	%	Nr	СЛ						
P1	P1000	3000	14-06-96	air	23	50			1	2	3	4	5	6
P1	P1000	3000	14-06-96	air	80		6	т	7	8	9	10	11	12
P1	P1000	3000	14-06-96	RME 100%	80		6	C113	13	14	15	16	17	18
P1	P1000	3000	14-06-96	RME 15%	80		6	C114	19	20	21	22	23	24
MATERIA	LS	Time	Date	MEDIA	TEMP	RM	Oven nr	Cylinder	5000		nrs			
Code	Type	hours			°C	%	Nr	Nr						
P1	P1000	4000	1997-1997-1996-1996-1997-1997-1997	air	23	50	10101010101010101010101010101010101010	141010101010101010101010101010101010101	25	26	27	28	29	30
P1	P1000	4000		air	80		6	Т	31	32	33	34	35	36
P1	P1000	4000		<b>RME 100%</b>	80		6	C113	37	38	39	40	41	42
P1	P1000	4000		RME 15%	80		6	C114	43	44	45	46	47	48
MATERIA	LS	Time	Date	MEDIA	TEMP	RH	Oven nr	Cylinder	Spec	iman	nrs			
Code	Туре	hours			°C	%	Nr	Nr						
P1	P1000	5000		air	23	50			49	50	51	52	53	54
P1	P1000	5000		air	80		6		55	56	57	58	59	60
P1	P1000	5000		RME 100%	80		6	C113	61	62	63	64	65	66
P1	P1000	5000		<b>RME 15%</b>	80		6	C114	67	68	69	70	71	72

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## Appendix 3A

## Set up of the ageing programme for PA12

## MATERIALS

File code

MAICN	ALS		
Code	Identification	Batch	Date inj. moulding
	PA12	Rilsan A AMN0TLD	08-02-96

PA12RME2.xls

## MEDIA AND

Code	Medium	Temp. C C	comments/composition
M1	RME 100%	80 S	ee LJ CTCAR2/832/95 Arie Kramer, Appendix 50
M2	RME 15%	80 F	ME/Diesel 15% mass, See.
		L	J CTCAR2/832/95 Arie Kramer Appendix 50
MЗ	AIR	80 E	ffect of temperature on the behaviour of polymer
M4	AIR	23 F	Reference condition, RH 50%.

## AGING TIMES AND DATES OF

Time	Time	Days	Hours	Date of
Code	hours			testing
A0	0	0	0	15-02-96
A1	120	5	0	20-02-96
A2	360	15	0	01-03-96
A3	1008	42	0	28-03-96
A4	2016	84	0	09-05-96
A5	3024	126	0	20-06-96

## MONITORING TESTS

Test code	Description	Standard	Specimen	Temp. of	Monitoring properties
		method	Туре	test °C	
T1	Tensile properties	ISO527	Dumbbell	23	Mod, Yid, Brk, (stress/strain)
T2	Dimensional change	LJ11896	Dumbbell	23	Thickness and width change
Т3	Mass change	LJ11896	Dumbbell	23	Mass change
T4	Yellowness	DIN6167	Dumbbell	23	Yellowness change
T5	Volatiles		Dumbbell	23	Volatiles change

Appendix 3B
Set up of the ageing programme for PA12
Details of the starting of the ageing test on
Details of RME used for testing: Supplier: NOVAOL
Drum, 5L contents according to the label.
Drum code Ref 5248 datum: 15-04-97
Filling of cylinders with HME
Cylinder code: Volume, mi Material Level, %
Mixing of RME and diesel
ml g
RME 75 72.1
Diesel 425 393.9
Ratio, % 15 15.4721
Remarks: The liquids are shaked well in an erlenmeier for about 3 minutes at RT
Filling of cylinders with RME
Date: 15-02-96, Arie Kramer and Wilma v. Straaten
Time of placement in ovens at °C: 11:10
Procedure for the removal of specimens from the cylinders
Cylinders were withdrawn from the oven and allowed to cool for about 30 min. before opening. It was observed that by only wiping of the tensile bars from the RME in the cylinders the surface was fatty and seemed to have a glossy appearance. Therefore it was tested whether the specimens could be cleaned better by rinsing with a solvent. From earlier experiments it was found that toluene is a good solvent for RME. Therefore all specimens tested were dipped in toluene and stirred for about 5 seconds in a cylinder with about 300 ml toluene . Immediately thereafter the specimens were dried with a clean cloth. Immediately after drying the mass of each set of 6 specimens was determined. The specimens were tested for the mechanical properties and the yellowness within 3 hours after removal from the cylinders.

## Appendix 4A

## Set up of the ageing programme for HDPE

MATERIALS

Code	Identification	Batch	Date inj. moulding							
P2	HDPE	Lupolen 5021D	25-04-96							

## MEDIA AND TEMPERATURES

Code       Medium       Temp. C       Comments/composition         M1       RME 100%       60       See LJ CAR2/118/96 addendum no 2         M2       AIR       60       Effect of temperature on the behaviour of polymer						
M1       RME 100%       60 See LJ CAR2/118/96 addendum no 2         M2       AIR       60 Effect of temperature on the behaviour of polymer	Code	Medium	Medium Te	emp. C	Comments/composition	
M2 AIR 60 Effect of temperature on the behaviour of polymer	M1	RME 100%	RME 100%	60	See LJ CAR2/118/96 addendum no 2	
	M2	AIR	AIR	60	Effect of temperature on the behaviour of polyme	er
M3 AIR 23 Reference condition, RH 50%.	M3	AIR	AIR	23	Reference condition, RH 50%.	

## AGING TIMES AND DATES OF TESTING

Time	Time	Days	Hours	Date of
Code	hours			testing
A0	0	0	0	14-06-96
A1	72	3	0	17-06-96
A2	480	20	0	04-07-96
A3	984	41	0	25-07-96
A4	1000	41	16	25-07-96
A5	1992	83	0	05-09-96
A6	3000	125	0	17-10-96
A7	4008	167	0	28-11-96
A8	5016	209	0	09-01-97

## MONITORING TESTS

Test code	Description		Standard	andard Specimen Ter		Monitoring properties				
			method	Туре	test °C					
T1	Tensile properties		ISO527	Dumbbell	23	Mod, Yld, Brk, (stress/strain)				
T2	Dimensional change		LJ11896	Dumbbell	23	Thickness and width change				
T3	Mass change		LJ11896	Dumbbell	23	Mass change				
T4	Yellowness		DIN6167	Dumbbell	23	Yellowness change				
T5	Volatiles			Dumbbell	23	Volatiles change				

Appendix 4B

#### Set up of the ageing programme for HDPE

Details of the starting of the ageing test on 140696										
Details of RME used for testing: Supplier: NOVAOL Drum, 5L contents according to the label.										
Drum code Ref 52	48 datum:	15-04-97								
Filling of cylinders	with RME									
Cylinder code:	Volume,ml Material	Level, %								
110	375 RME	100								
111	370 RME	100								
112	415 RME	100								
Date:		14-06-96								
Time of placemer	nt in ovens at 60 °C:	10:00								
Oven codes:										
material	Oven									
HDPE	15									

## Procedure for the removal of specimens from the cylinders

Cylinders were withdrawn from the oven and allowed to cool for about 30 min. before opening. It was observed that by only wiping of the tensile bars from the RME in the cylinders

the surface was fatty and seemed to have a glossy appearance.

Therefore it was tested whether the specimens could be cleaned better by rinsing with a solvent. From earlier experiments it was found that toluene is a good solvent for RME.

Therefore all specimens tested were dipped in toluene and stirred

for about 5 seconds in a cylinder with about 300 ml toluene .

Immediately thereafter the specimens were dried with a clean cloth.

Immediately after drying the mass of each set of 6 specimens was determined.

The specimens were tested for the mechanical properties and the yellowness within 3 hours after removal from the cylinders.

# Appendix 4C

# Ageing programme for HDPE, specimens arrangement

<u>AGEIN</u>	<u>G PROG</u>	RAMME	<u>IS FOR</u>	POLYM	ERS									
Project:		Effect of Extension	RME on th n of the ru	ne perform Inning BM	ance of I E program	idpe L								
Summar	y of speci	nen codes				I		ľ	ľ					
MATER. Core	ALS Type	Time hours	Date	MEDIA	TEMP °C	FH %	Oven nr Nr	Cylinder Nr	5	<u></u>	n nre			
P2	HDPE	0	Ref 3-6-9	air	23	50	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		20102010101011011 	101010101010101010 1	100010010000000000000000000000000000000	1999-9999-9999	*12270703030303980	4:5:5:5:5:5:5:5:5:5:5:5:5:5:5:5:5:5:5:5
P2	HDPE	0												
P2	HDPE	0			*********			000000000000000000000000000000000000000					444444444	
MATERI	ALS	Time	Date	MEDIA	TEMP	RH	Oven nr	Cylinder	Spe	cime	n nra	1		
Code	Туре	hours			°C	%	Nr	Nr .						
P2	HDPE	75		air	23	50			7	8	9	10	11	12
P2	HDPE	75		air	60				25	26	27	28	29	30
P2	HDPE	75	17-06-96	100% RM	60		15	110	501	502	503	504	505	506
MATERI Coce	ALS Type	Time hours	Date	MEDIA	TEMP °C	RH %	Oven nr Nr	Cylinder Nr	Spe	cime	n nrs			
P2	HDPE	150		air	23	50			61	62	63	64	65	66
P2	HDPE	150		air	60				79	80	81	82	83	84
P2	HDPE	150		100% RM	60		15	110	507	508	509	510	511	512
MATERI Code	ALS Type	Time hours	Date	MEDIA	°C	RH %	Oven nr Nr	Cylinder Nr	Spe	cime	n nrs	I		
P2	HDPE	500		air	23	50			115	116	117	118	119	120
P2	HDPE	500		air	60				133	134	135	136	137	138
P2	HDPE	500	04-07-96	100% RM	60		15	110	513	514	515	516	517	518
MATERI Code	ALS Type	Time hours	Date	MEDIA	TEMP °C	RH %	Oven nr Nr	Cylinder Nr	Spe	cime	n nrs			
P2	HDPE	1000		air	23	50			169	170	171	172	173	174
P2	HDPE	1000		air	60				187	188	189	190	191	192
P2	HDPE	1000	25-07-96	100% RM	60		15	111	519	520	521	522	523	524

# Appendix 4D

# Ageing programme for HDPE, specimens arrangement

MATERIA	LS	Time	Date	MEDIA	TEMP	<b>RH</b>	Oven nr	Cylinder		eimei	1 NI S			
Code	Type	hours			°C	%	Nr	Nr						
P2	HDPE	2000		air	23	50			223	224	225	226	227	228
P2	HDPE	2000		air	60	-			241	242	243	244	245	246
P2	HDPE	2000	05-09-96	100% RM	60	1	15	111	525	526	527	528	529	530
MATERIA	LS	Time	Date	MEDIA	TEMP	AH	Oven nr	Cylinder	Spe	cime	n nrs			
Code	Туре	hours			°C	%	Nr	Nr						
P2	HDPE	3000		air	23	50			277	278	279	280	281	282
P2	HDPE	3000		air	60				295	296	297	298	299	300
P2	HDPE	3000	17-10-96	100% RM	60		15	111	531	532	533	534	535	536
	LS	Time	Date	MIZDIA	TEMP	RH	Oven nr	Cylinder		1	1110			
Code	Туре	hours			°C	%	Nr	Nr						
P2	HDPE	4000	000000000000000000000000000000000000000	air	23	50			331	332	333	334	335	336
P2	HDPE	4000		air	60				349	350	351	352	353	354
P2	HDPE	4000	27-11-96	100% RM	60	-	15	112	537	538	539	540	541	542
MATERIA	LS	Time	Date	MEDIA	TEMP	RH	Oven nr	Cylinder	Spe	eime	n nra			
Code	Type	hours			°C	%	Nr	Nr						
P2	HDPE	5000	**********	air	23	50			385	386	387	388	389	390
P2	HDPE	5000		air	60				403	404	405	406	407	408
P2	HDPE	5000	08-01-97	100% RM	60		15	112	543	544	545	546	547	548

## Appendix 5:

Drawing of the test cylinders and racks used for ageing tests





#### List of Abbreviations

- EC **European Commission**
- EΡ European Parliament
- OEM Original Equipment Manufacturer HDPE High Density PolyEthylene
- MTBE Methyl Tertiary Butyl Ether
- **Rapeseed Methyl Ester** RME
- International Standards Organisation ISO
- Room temperature RT
- RH
- Relative humidity Deutsche Industrie Norm DIN
- Yellowness Index YI

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