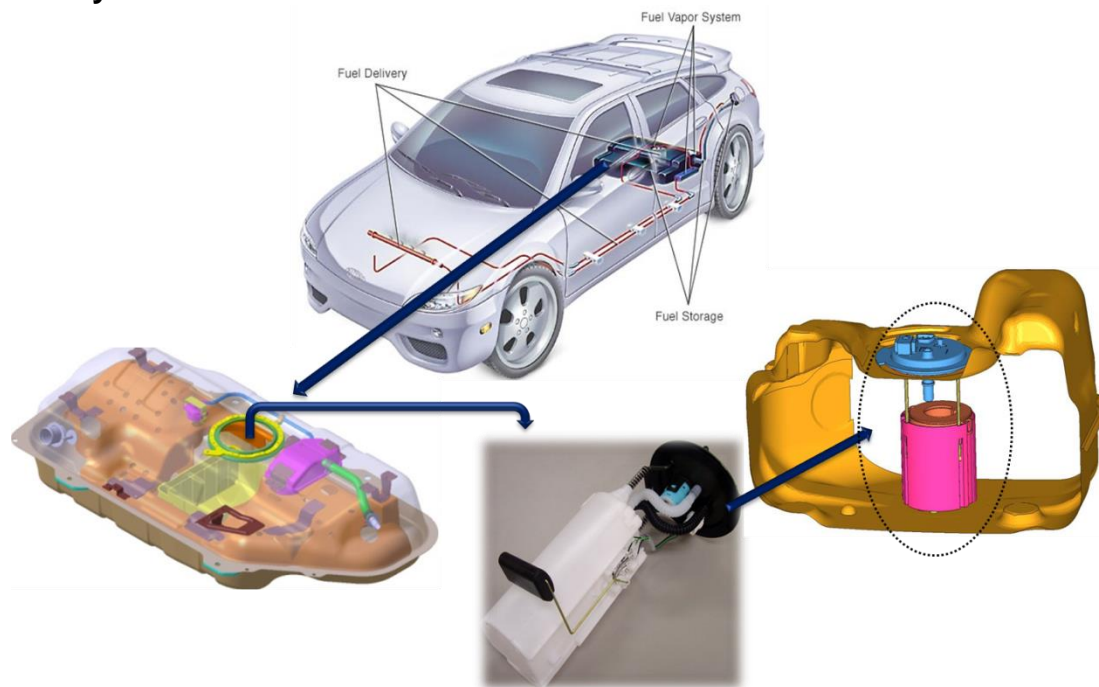


Fuel Resistance of KEPITAL

R&D Center

1. Fuel Systems and KEPITAL



Fuel pump module is the most relevant automotive module to POM. The POM weight of one single fuel pump module can come in at around 600 g ; the largest weight ratio for a single module. Demand for POM to be used in fuel pump module all over the world totals over 100,000 tons, and KEPITAL has a fuel system market share of 10 %.

Why KEPITAL For fuel system?

- Excellent fuel resistance to various fuel types
- Optimized material for each fuel system part
- Vast experience in fuel systems and technical know-how after a Korea first of replacement of metal fuel pump module with plastic ones
- Various OEM approval from GM, Ford, Chrysler, BMW, Daimler, Hyundai/KIA, etc.
- Quality consistency

<KEPITAL Major Grades>

- (1) Standard grades : KEPITAL F20-03, F10-03H
- (2) Conductive grades : KEPITAL ET-20A, FA-20, SF-20, CNT- Filled grade
- (3) Hot diesel grades : KEPITAL FR-20H

2. Fuel composition

(1) Test standards

1) International test standards

	ASTM D471 / ISO 14469	ISO 1817	DIN 51604	SAE J1681 /1748
Abbreviation	ASTM/ISO	ISO	DIN	SAE

2) Automotive company test standards

	FORD	GM	OPEL	Renault	Volvo	Delphi
Abbreviation	FORD	GM	OPEL	Ren.	Volvo	Del.

(2) "Iso-octane+Toluene" Fuel

Fuel name	Standard	Iso-octane (%)	Toluene (%)
Fuel A	ASTM/ISO	100	-
Liquid A	ISO		
Fluid A	Ren.		
Fuel B	ASTM/ISO	70	30
Liquid B	ISO		
Fluid B	Ren.		
Fuel C	ASTM/ISO	50	50
Liquid C	ISO		
Fluid C	Ren.		
STD Test Liquid 1	Volvo	60	40
Fuel D	ASTM/ISO		
Liquid D	ISO		
Fluid D	Ren.	-	100
Fuel E	ASTM/ISO		
Liquid E	ISO		

(3) "Iso-octane+Toluene+Alcohol+Di-isobutylene" Fuel

Fuel name	Standard	Iso-octane (%)	Toluene (%)	Me-OH (%)	Et-OH (%)	Di-isobutylene (%)
TF1	GM	40	50	-	10	-
TF2	GM	27.5	50	5	2.5	15
MTF2	Del.	46.25	46.25	2.5	5	-
Fuel H	ASTM/ISO	42.5	42.5	-	15	-
Fuel I	ASTM/ISO	42.5	42.5	15	-	-
Liquid 4	ISO					
Fluid O	Ren.					
Fuel K	ASTM/ISO	7.5	7.5	85	-	-
FAM A	DIN	30	50	-	5	15
Liquid 1	ISO					
GME L 0001	OPEL					
Liquid 3	ISO	45	45	3	7	-
Fluid N	Ren.					

(4) "Fuel B or C + Additives" Fuel

Fuel name	Standard	Fuel B (%)	Fuel C (%)	Me-OH (%)	Additives
GM6264M Sour Gasoline	GM	100	-	-	TBHP (50mmol/l) +Cu ⁺ solution (10ml/l)
FLTM AZ-105-01	FORD	-	100	-	TBHP (50mmol/l) +Cu ⁺ ion (0.01mg/l)
FLTM BP 114-02	FORD	-	85	15	NaCl (5mg/l) +Formic acid (0.05ml/l)
FLTM BZ 105-03 (PN180 + Cu ⁺ solution)	FORD	-	100	-	TBHP(180mmol/ l) +Cu ⁺ solution (10ml/l)

(5) "Fuel C+Additives(aggressive, corrosive)" Fuel

Fuel name	Standard	Fuel C (%)	Me-OH (%)	Et-OH (%)	Additives
FLTM BZ 105-03 (CM15A)	FORD	85	15 (A)	-	(A) Aggressive Me-OH(1ℓ) = Anhydrous Me-OH (995mℓ) + Formic acid (0.028mℓ/ℓ) + Aggressive water (5mℓ) * Aggressive water(1ℓ) = Distilled water + NaCl (0.99g) + Na ₂ SO ₃ (0.888g) + NaHCO ₃ (0.828g)
CE10A	Del.	90	-	10 (A)	(A) Aggressive Et-OH(100mℓ)= Anhydrous Et-OH(93mℓ)+Distilled water(0.15mℓ) +CuSO ₄ solution(0.01 mg/ℓ)+TBHP(6.8mℓ) +NaCl (0.005g)+Formic acid(0.05mℓ)
Worst fuel case (Brazil)	GM	79	-	20	** Corrosive water(1%) addition Corrosive water(1ℓ)=Distilled water(1ℓ)+ NaCl(198mg/ℓ)+Na ₂ SO ₃ (148mg/ℓ)+Ethyl acetate(1.67mℓ/ℓ)+ HCHO(1.33mℓ/ℓ))+Acetic acid(1.50mℓ/ℓ))

(6) "Fuel C+Me-OH" Fuel

Fuel name	Standard	Fuel composition
CM__(A, P)	SAE	C=Fuel C, M=Me-OH A: Aggressive Me-OH(1 ℓ)= Anhydrous Me-OH(995mℓ)+Aggressive water(5mℓ) *Aggressive water(1 ℓ)=Distilled water(990mℓ)+ Formic acid(10mℓ)+NaCl(1 mg)+Na ₂ SO ₄ (8mg) P: TBHP (50mmol/ ℓ) + Cu ⁺ ion (0.01 mg/ℓ)

(7) "FAM A + Additive" Fuel

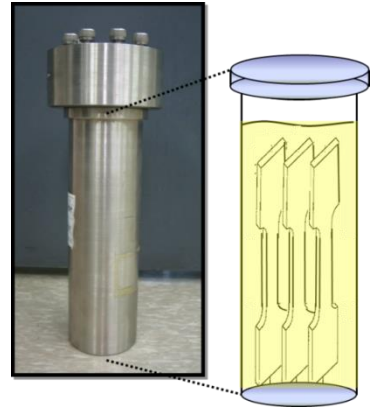
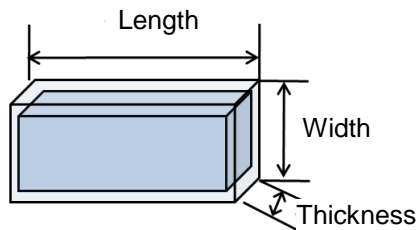
Fuel name	Standard	FAM A (%)	FAM B (%)	Me-OH (%)	Water (%)	Additives
FAM B	DIN	84.5	-	15	0.5	-
Liquid 2	ISO					
GME L 0003	OPEL	-	100	-	-	Formic acid (20ppm)
FAM C	DIN	40	-	58	2	-

3. KEPITAL fuel resistance

(1) Fuel resistance test in closed systems

1) Test method(ISO 175, ASTM D543, SAE J1748)

- Vessel type : Completely sealed steel vessel(volume: 500 cm³)
- Temperature control: Vessel in UL heating oven
- Fuel change : Every 4 weeks(5000 h test),
No change(1000 h test)
- Measurement of weight and dimensional change : Remove specimen from the vessel and wipe off fuel on surface and then proceed to measurement

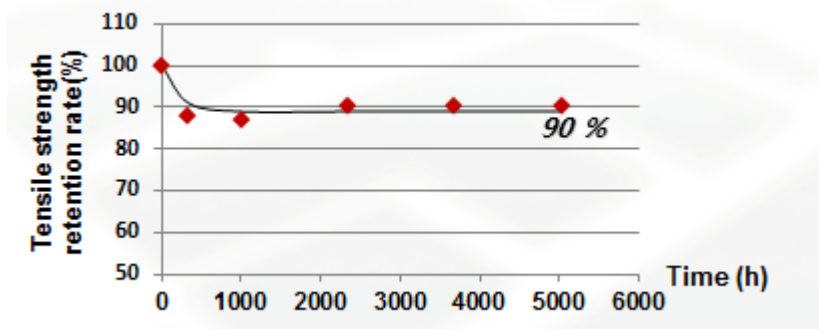


- Measurement of mechanical property changes : Remove specimen from the vessel and then keep the specimen in PE bag for one hour and proceed to measurement

2) Test results

① Standard grade : KEPITAL F20-03

- Retention rate of tensile strength after soaking in gasoline(TF 1, 5000 h, 65 °C) : 90 %



- Retention rate of tensile strength after soaking in gasoline
(CE85, CM85, CM15, 5000 h, 65 °C)

Fuel type	Composition	Retention rate (%)
CE85	Fuel C + Et-OH 85 %	87
CM85	Fuel C + Me-OH 85 %	87
CM15	Fuel C + Me-OH 15 %	86

※ Less than 3 % of weight increase and less than 2 % dimension increase after 1,000 h.
(No further change after 5,000 h)

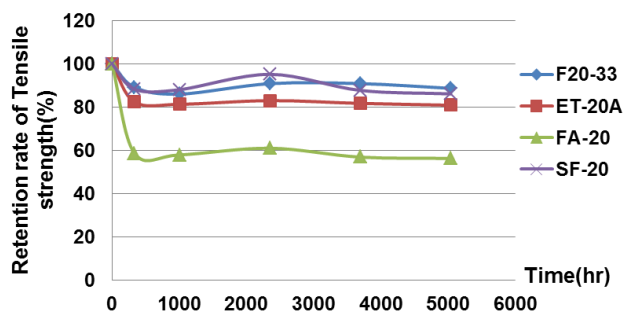
- Retention rate of tensile strength after soaking in diesel
(SME 20, RME 30, RME 05, 5000 h, 90 °C)

Fuel type	Composition	Retention rate (%)
SME 20	20% SME(Soy-bean Methyl Ester) + 80% Diesel	94
RME 30	30% RME(Rape-seed Methyl Ester) + 70% Diesel	99
RME 05	5 % RME(Rape-seed Methyl Ester) + 95% Diesel	99

※ Less than 1 % of weight and dimension increase after 1,000 h.(No further changes after 5,000 h)

② Conductive Grade: KEPITAL ET-20A, FA-20, SF-20

- Retention rate of tensile strength after soaking in gasoline CE85 (5000 h, 65 °C)

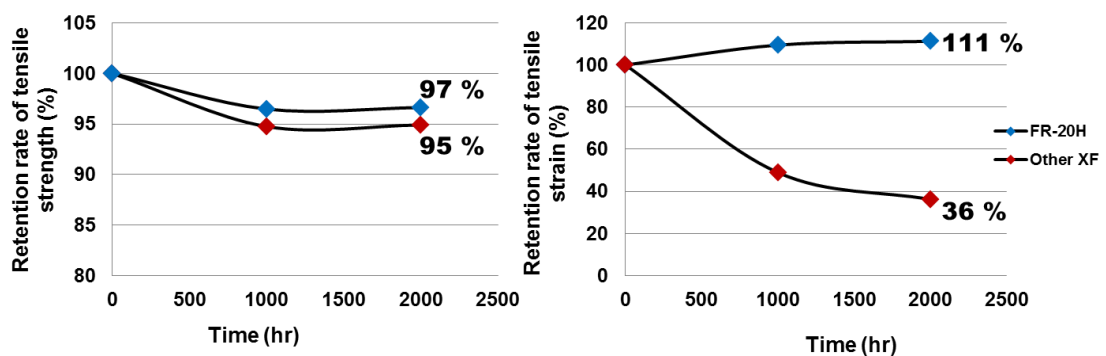


Grade	Strength before soaking (MPa)	Strength after soaking (MPa)	Retention rate of tensile strength (%)
ET-20A	47	38	81
FA-20 ^{*note 1)}	85	48	56
SF-20	55	48	86

*note 1) In the case of FA-20, retention rate of tensile strength is low due to swelling, but strength after soaking is higher than other conductive grades.

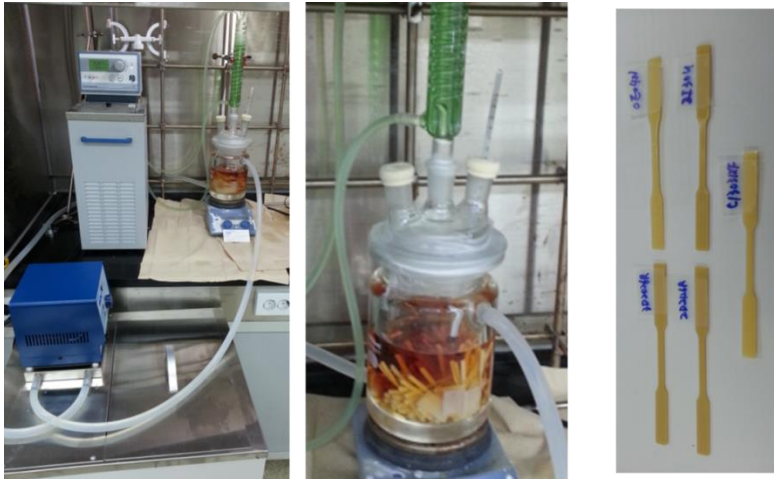
③ Hot-diesel Grade: KEPITAL FR-20H

- Retention rate of tensile strength after soaking in diesel(+0,15 % sulfur) (2000 h, 120 °C)



(2) Fuel resistance test in open system

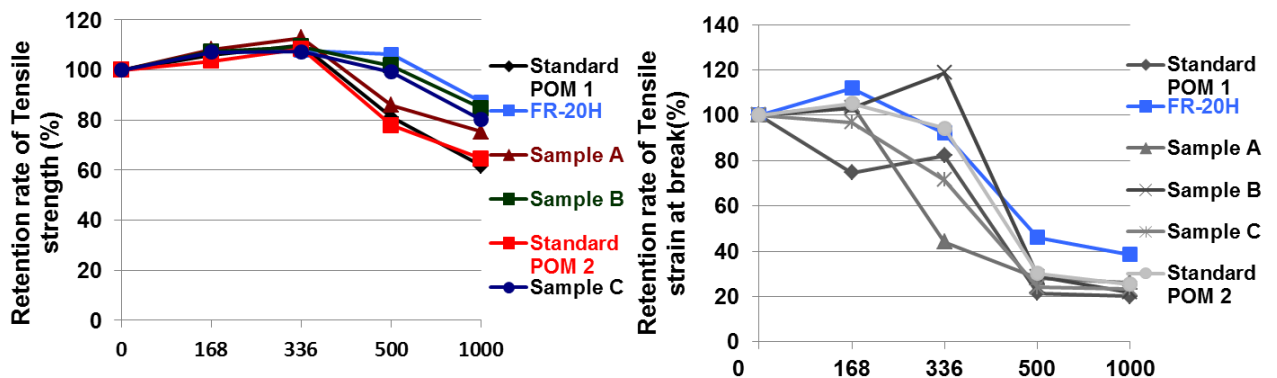
1) Test process : Circulate 60 l air for one hour



2) Test results

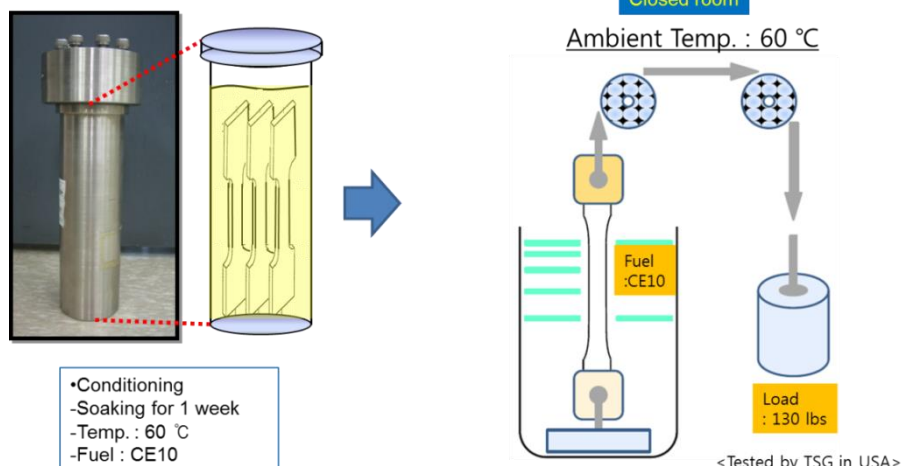
① Test condition : Normal Diesel(Oxidized fuel), 100 °C, 1000 h soaking

② Retention rate of tensile strength and strain : FR-20H, hot-diesel grade has outstanding tensile strength retention rate and strain after soaking in fuel for 1000 hours compared with competitor's grade and KEPITAL standard grade.



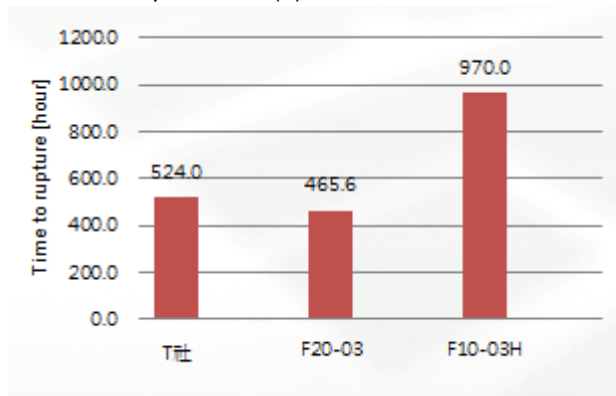
(3) Creep rupture fuel resistance test

1) Test process : Measure rupture time and deformation length of specimen after soaking in 60 °C fuel under constant load

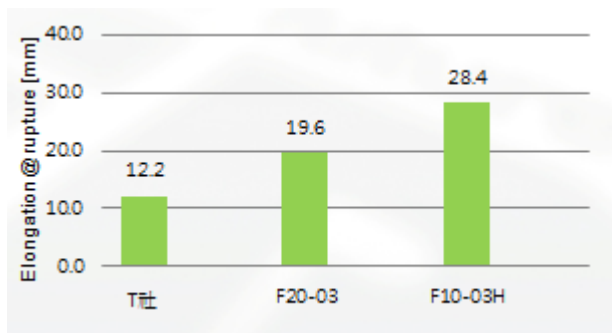


2) Test results

- Rupture time(h)



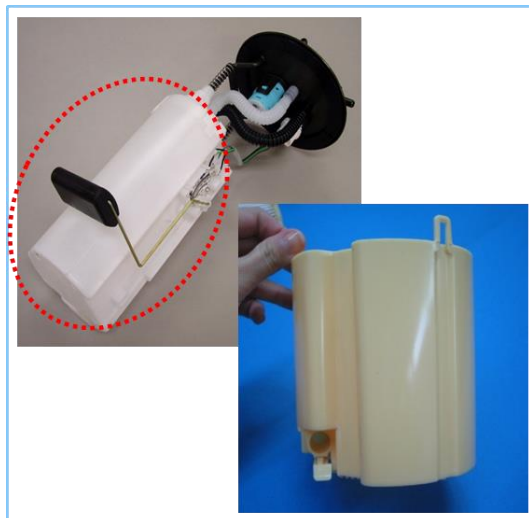
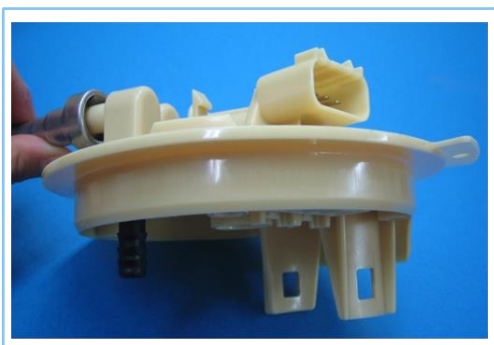
- Deformation length(mm)



4. Case study

(1) Reservoir & Flange

- 1) For gasoline: KEPITAL F20-03
- 2) For diesel: KEPITAL FR-20H



(2) Filter housing

- 1) Nonconductive(Standard) grades: KEPITAL F20-03, F10-03H
- 2) Conductive grades: KEPITAL FA-20, ET-20A, SF-20



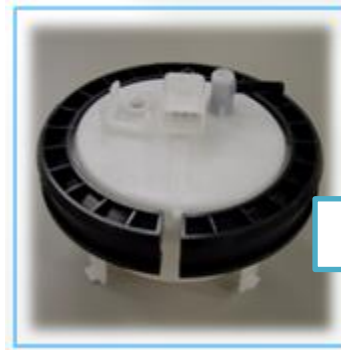
(3) Fuel pump assembly

- 1) Reinforced Grade: KEPITAL FG2025(Medium viscosity, GF25%), FG2030(Medium viscosity, GF30%), FG1025(High viscosity, GF 25%), FG2025D(Low viscosity, GF25%), FG2025T(PTFE-modified), FB2030(Glass Bead 30 %)



(4) Others

- 1) Fuel pump baffle: KEPITAL F30-03
- 2) Ring-lock: KEPITAL F20-03
- 3) Fuel filler neck: KEPITAL ET-20A



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