BAKER HUGHES Technology

Specialty Polymers for PVC



Introduction and Product Overview

September 2012

Baker Hughes Specialty Polymers - Overview

- **Products**: **Low Molecular Weight Polymers** and waxes
- **Main end uses**: **Additives** to formulated products
  - Modify thermal, surface and other properties
- **Market focus**: **Plastics, Imaging and Coatings, Adhesives, Personal Care**
- **Strategy**: Work closely with customers to create **Value Adding Solutions**

Fischer-Tropsch polymers

- Polymers produced by Shell MDS (Malysia)
  - Polymers are 90 – 95% normal paraffins
  - Remaining 5 – 10% are branched hydrocarbons
- Baker Hughes is an authorized distributor
  - Americas, Middle East, China, Africa

Product	Congealing Point (°F / °C)	Viscosity (cps)	Penetration @ 77°F / 25°C (dmm)	Oil Content (%)
Shell GTL Sarawax SX-105	221 / 105	25 @ 130°C	1	0.25

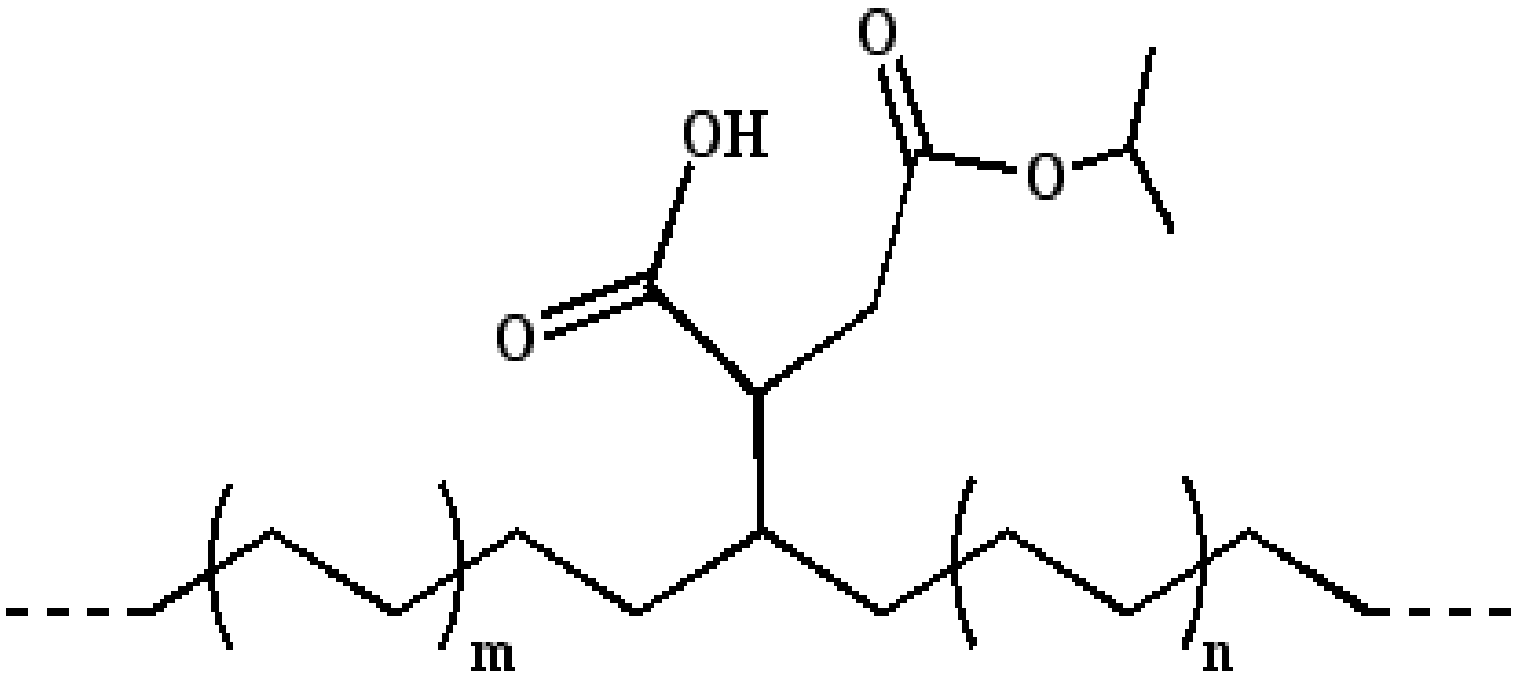
BARECO ™ C-4040 polymer

- Synthetic polyethylene
  - Linear, fully saturated, low polydispersity, high crystallinity

Product	Drop Melt Point (°F/°C)	Viscosity (SUS) @ 300°F	Pen @ 77°F (dmm)	Pen @ 140°F (dmm)
BARECO™ C-4040 polymer	218 / 104	54	1.5	9.5

CERAMER™ 67 Polymer

CERAMER™ 67 Polymer is a grafted maleic anhydride ethylene polymer derivative

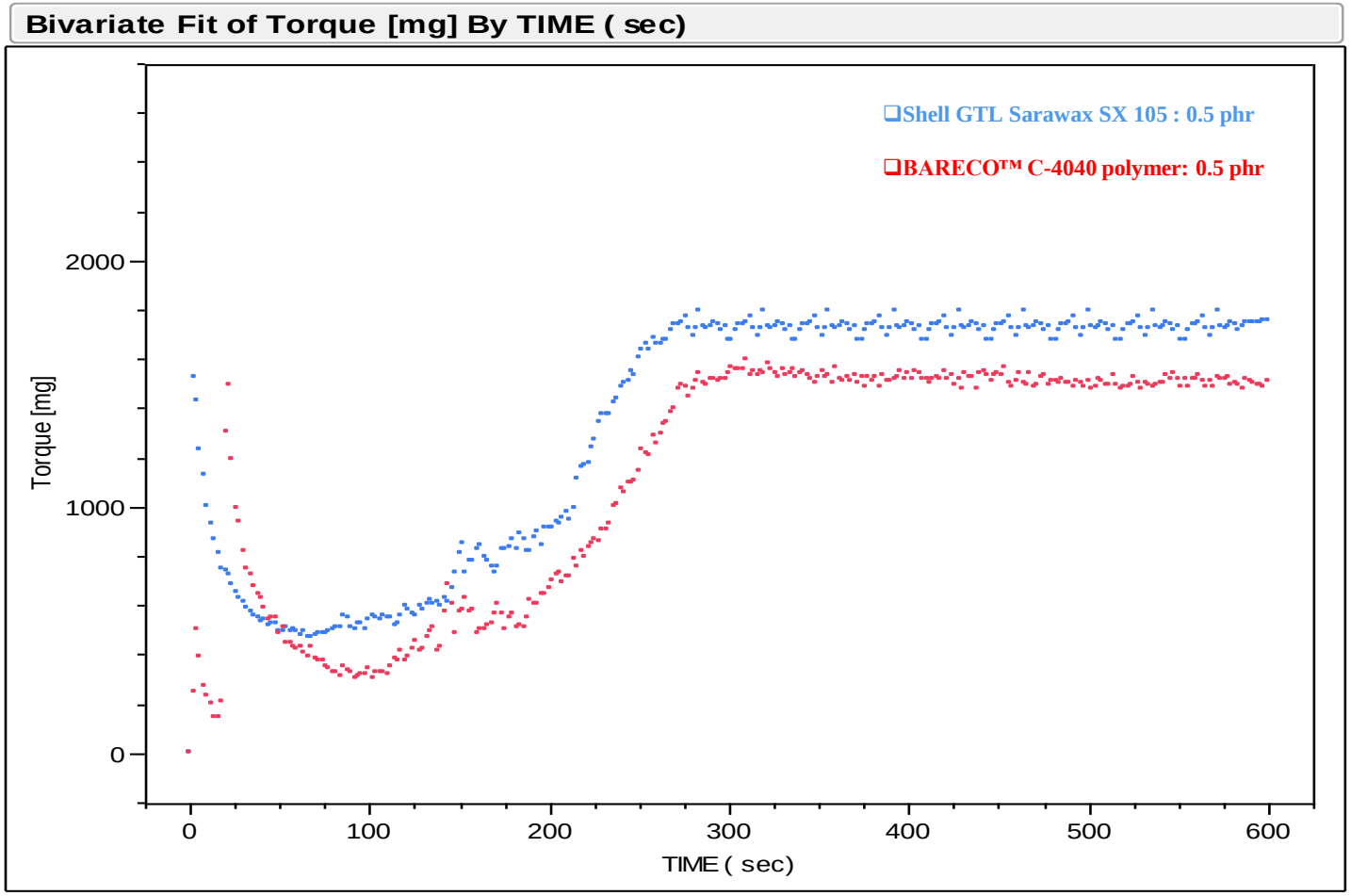


CERAMER™ 67 Polymer

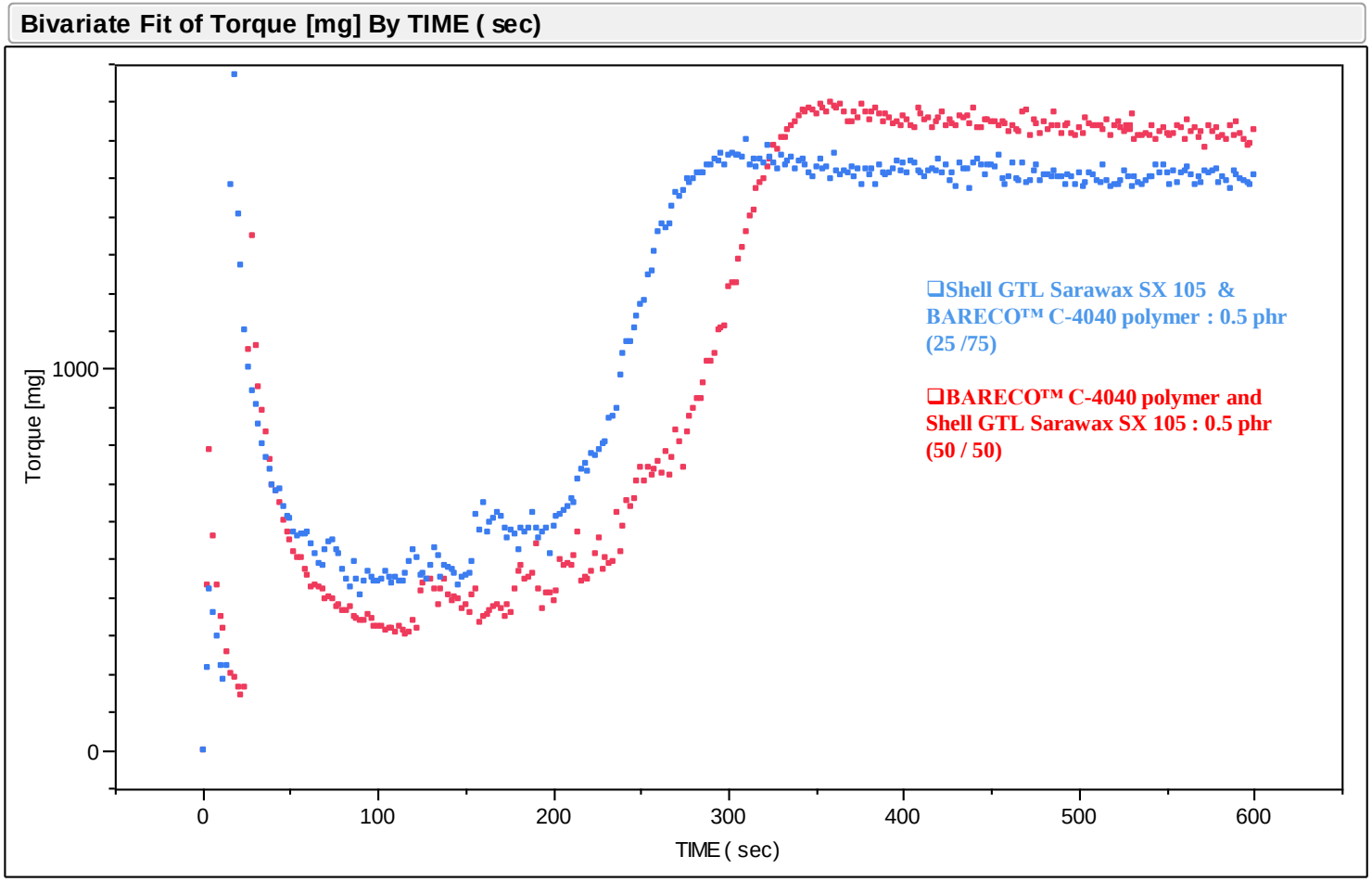
- Low molecular weight linear polyethylene grafted with maleic anhydride

Product	Melt (° C)	Acid Number	SAP Number	Pen @ 25° C (dmm)
CERAMER 67 polymer	96	48	77	3.0

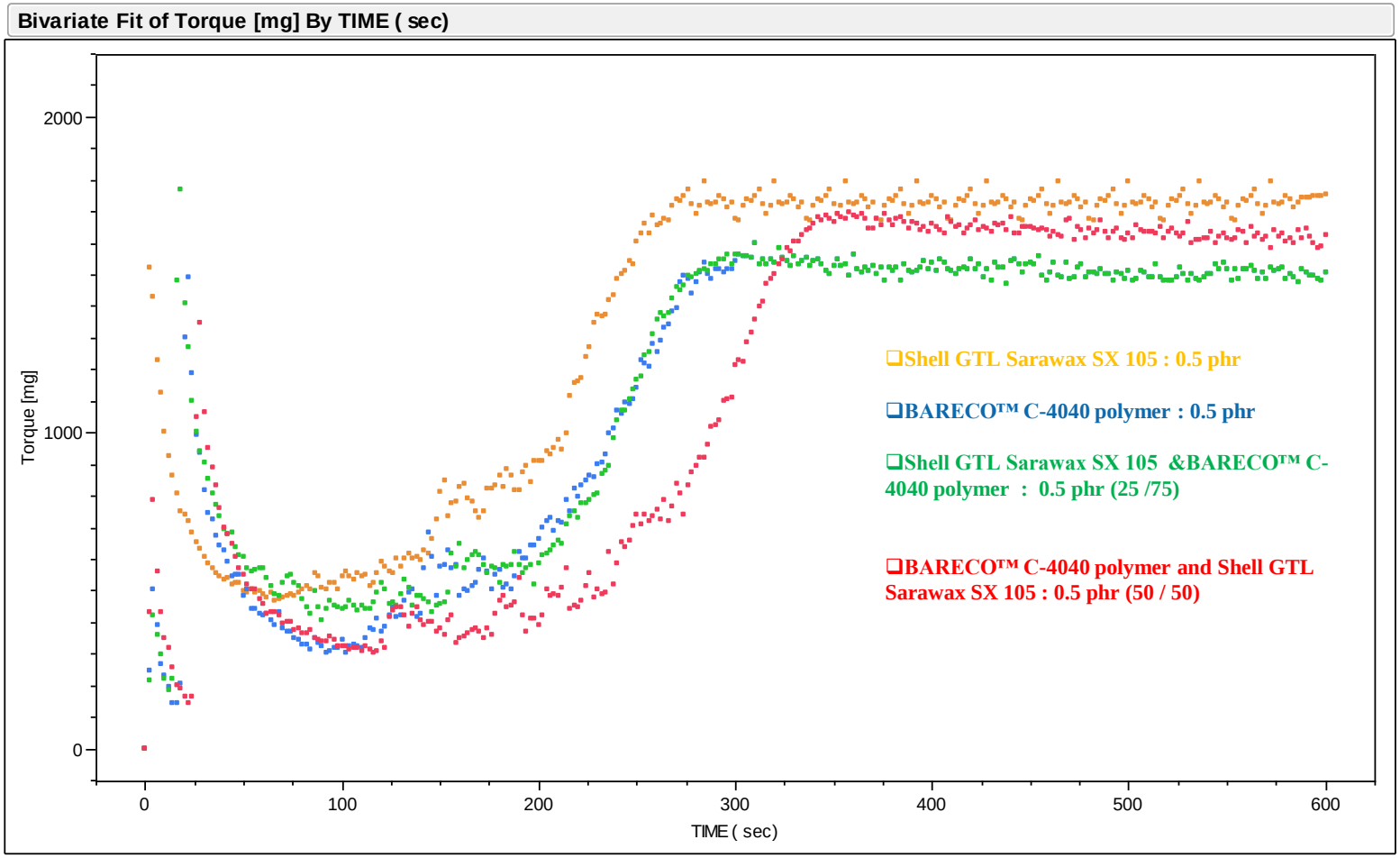
Baker Hughes Test 1a : Comparative PVC Torque Curves with Calcium Zinc Stabilizers



Baker Hughes Test 1b : Comparative PVC Torque Curves with Calcium Zinc Stabilizers



Baker Hughes Test 1c : Comparative PVC Torque Curves with Calcium Zinc Stabilizers



Test 1a Observations: comparing BARECO™ C-4040 polymer VS Shell GTL Sarawax SX 105

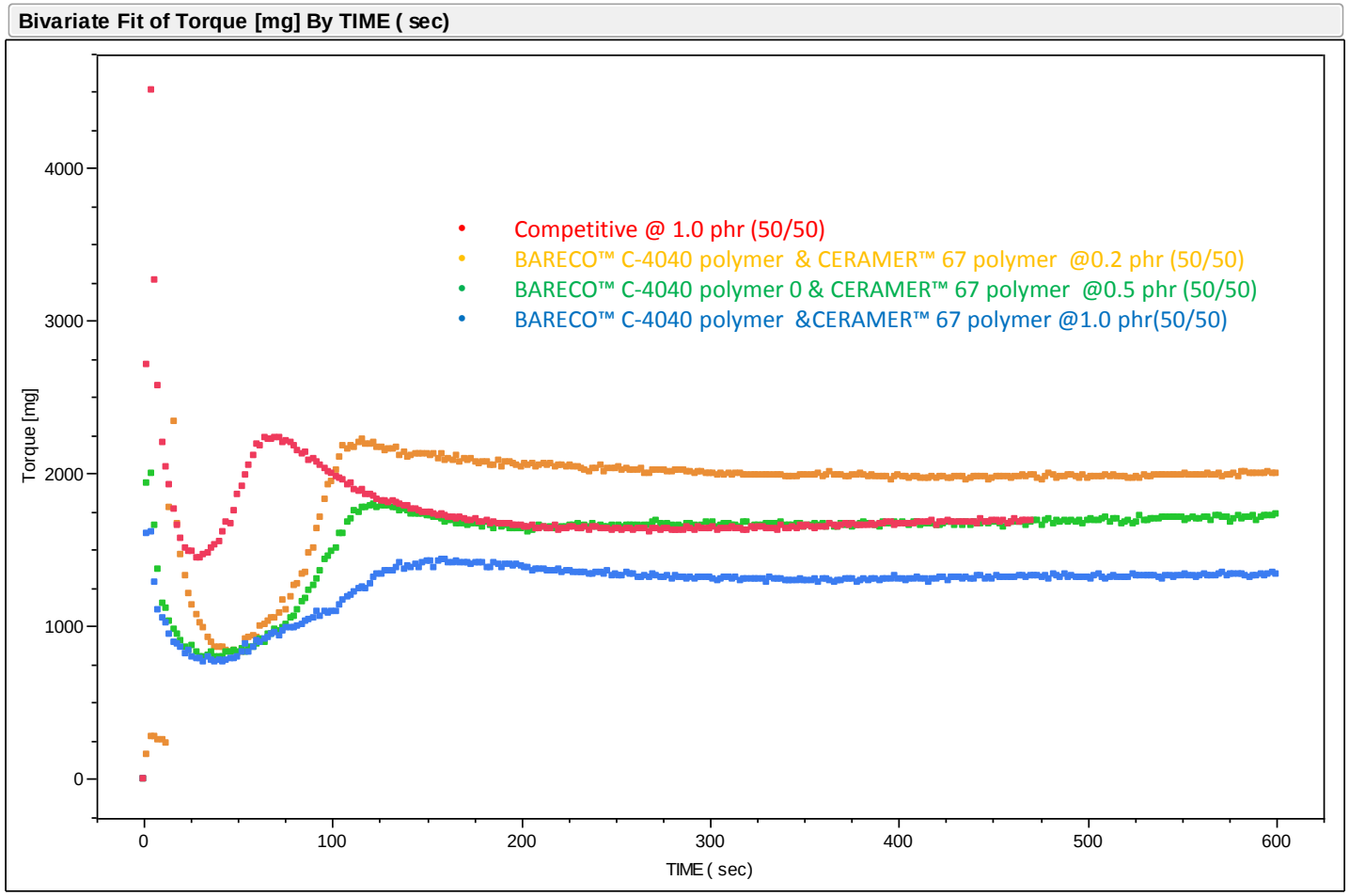
- At 0.5% loading, the BARECO™ C-4040 polymer provides
  - Similar fusion time to Shell GTL Sarawax SX 105
  - Lower melt torque than Shell GTL Sarawax SX 105
  - Lower fusion torque than Shell GTL Sarawax SX 105

- At 0.5 % loading the 50/50 blend of BARECO™ C-4040 & Shell GTL Sarawax SX 105 is too lubricious
  - Longer fusion time than Shell GTL Sarawax SX 105
  - Similar fusion torque to Shell GTL Sarawax SX 105
  - Similar melt torque to Shell GTL Sarawax SX 105

Test 1b Observations: comparing BARECO™ C-4040 polymer VS Shell GTL Sarawax SX 105 polymer

- At 0.5% loading the 75/25 blend of BARECO™ C-4040 & Shell GTL Sarawax SX 105 provide :
  - Similar fusion time to BARECO™ C-4040 polymer
  - Lower melt torque than Shell GTL Sarawax SX 105
  - Lower fusion torque than Shell GTL Sarawax SX 105

Test 2: Comparative PVC Torque Curves with CaZn Stabilizer; BARECO™ C-4040 polymer & CERAMER ™ 67 polymers vs. Competitive Grades



BARECO™ C-4040 polymer & CERAMER™ 67 Polymers Combination for Internal PVC Lubrication

Test 2 Results

- At 1 phr loading the 50/50 blend of **BARECO™ C-4040 polymer** & **CERAMER™ 67 polymer** is too lubricious
  - Lower melt torque
  - Lower fusion torque
  - Lower fusion time
- At 0.5 phr loading the 50/50 blend of **BARECO™ C-4040 polymer** & **CERAMER™ 67 polymer** demonstrate :
  - Similar melt torque
  - Lower fusion torque
  - Longer fusion time

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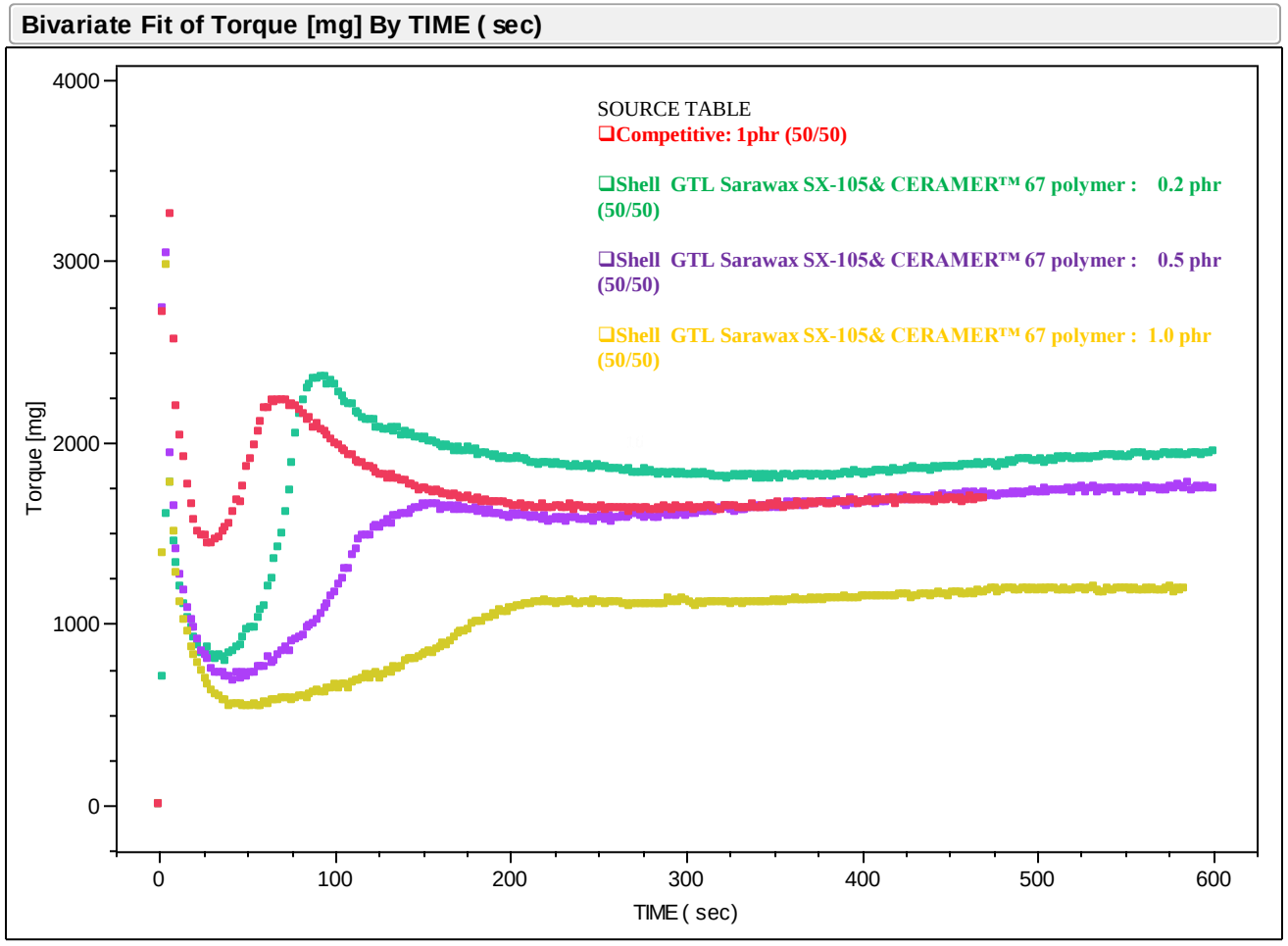
BARECO™ C-4040 polymer & CERAMER™ 67 Polymers Combination for Internal PVC Lubrication

Test 2 Results

- At 0.2 phr loading the 50/50 blend of **BARECO™ C-4040 polymer** & **CERAMER™ 67** polymer demonstrate
  - Higher melt torque
  - Longer fusion time
  - Lower fusion torque

Test 3: Comparative PVC Torque Curves with CaZn Stabilizer; Shell GTL Sarawax SX 105 polymer & CERAMER ™ 67 polymers vs. Competitive Grades



Sarawax SX 105 polymer & CERAMER™ 67 Polymers Combination for Internal PVC Lubrication

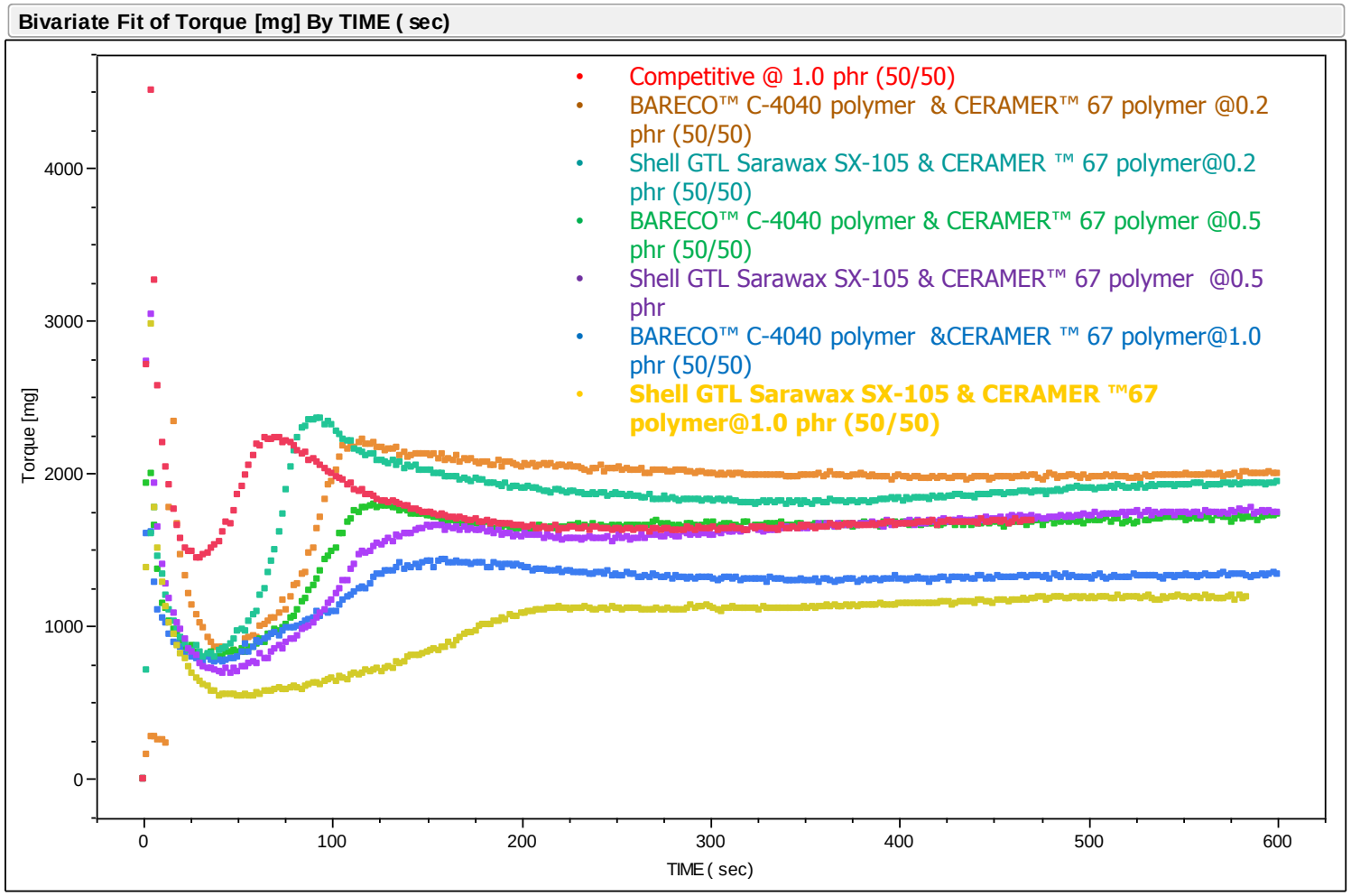
Test 3 Results

- At 1 phr loading, the competitive blends of oxidized and non-oxidized lubricants perform the same as each other

- At 1 phr loading the 50/50 blend of **Shell GTL Sarawax SX -105** & **CERAMER™ 67** Polymer is too lubricious

- At 0.2 phr loading the 50/50 blend of **Shell GTL Sarawax SX -105** & **CERAMER™ 67** Polymer performs more like the 1 phr loading of competitive blends

Combined : Comparative Torque Curves with CaZn Stabilizer; BARECO™C-4040 polymer & CERAMER ™ 67 polymers versus Shell GTL Sarawax SX 105 and Competitive Grades



BARECO™ C-4040 polymer & CERAMER™ 67 Polymers Combination for Internal PVC Lubrication

Test 4 Results

- At 1 phr loading the 50/50 blend of **Baker Hughes** Polymer is too lubricious
  - Lower melt torque
  - Lower fusion torque
  - Lower fusion time
- At 0.5 phr loading the 50/50 blend of **Baker Hughes** Polymers demonstrates :
  - Similar melt torque
  - Lower fusion torque
  - Longer fusion time

BARECO™ C-4040 polymer & CERAMER™ 67 Polymers Combination for Internal PVC Lubrication

Test 4 Results

- At 0.2 phr loading the 50/50 blend of **Baker Hughes** Polymers performs more like the 1 phr loading of competitive blends
  - Higher melt torque
  - longer fusion time
  - Lower fusion torque

Baker Hughes Polymers Combination for PVC Lubrication

Conclusions:

- Low loadings of **Shell GTL Sarawax SX-105 & CERAMER™ 67 polymer** blends provide torque and lubrication performance similar or better than that typical of competitive oxidized and non-oxidized lubricant blends at higher loading
- Low loadings of **BARECO™ C-4040 polymer & CERAMER™ 67 polymer** blends provide torque and lubrication performance similar or better than that typical of competitive oxidized and non-oxidized lubricant blends at higher loading

In Closing

- Baker Hughes Specialty Polymers specializes in low molecular weight polyolefin chemistry
- Work hand-in-hand to identify practical solutions
- Able to custom design to meet your needs
- Global reach

