Hydraulic Fluid for Wave Generation Systems

Eric Handley
VP Technology
MacDermid Offshore Solutions
Introduction

• As pioneers in the offshore oil and gas exploration and production MacDermid have significant experience in offshore sub-sea hydraulic fluids
• A renewable energy project team requested assistance with energy transmission fluid for a wave powered electricity generating system
• MacDermid realised they had a lot of relevant, transferable knowledge with water-based biodegradable fluids
Key Environmental Concerns

• Close to shore
• Shallow waters
• Use in environmentally sensitive areas
• Immediate effect to human health
• Eco-friendly politics related to renewable energy
Engineering challenges

• High power transfer required
• Long hydraulic lines
• Low power loss requirements
• Maximize efficiency
• Minimize contamination concern
• Maximize system life span
MacDermid Relevant Experience

- Low toxicity fluids including fluids for the Arctic environment
- Long offset hydraulics, over 180km hydraulic lines
- Field life of over 40 years
- Dilutable fluid for rig use, extremely cost effective
- Fluid fit for equipment storage
Low viscosity

- Low viscosity reduces ‘lag’
- Increases system response
- Slight reduction in efficiency due to internal leakage
- Overall low viscosity increases system efficiency
Low Compressibility

- High Bulk Modulus increases power transfer
- Reduces system response time
- Greatly reduces fluid use
- Can increase component wear, but with the speeds and pressures required this is negligible.
Use of water based fluid

- Low viscosity
- High biodegradability
  - Chemicals soluble in seawater
- Low toxicity
- High bulk modulus/low compressibility
- Three water-based fluid applications considered as a basis for a Wave Energy Conversion System
  - Subsea Production Control Fluids
  - Blowout Preventer Control Fluids
  - Motion Compensator Fluids
Use of Subsea Production Control Fluids

• High fluid cost
  – These fluids are high performance containing expensive chemistry and production

• These fluids need to be supplied in a pre-mixed form
  – for cleanliness and stability
  – Quality control at manufacturer
Use of BOP Control Fluids

• The BOP fluids have a relatively short life span
  – the biocides used for fluid preservation are only functional for the period of a drilling campaign, weeks rather than years.

• The BOP fluids tend to have a lower tolerance for seawater compatibility
  – low concentration used
  – reducing life of the fluid if seawater ingress should occur.
  – Degraded fluid will lose lubrication, corrosion protection and sediment will block filters and flow-lines.
Use of Motion Compensator Fluids

• The Motion Compensator fluids are supplied ready to use so volumes would be large
• The Fluids have a high viscosity due to the damping requirements
• The viscosity modifiers are poly glycols with low biodegradation potential
CETO – Carnegie Wave Energy Generation Plant
History of Fluid Selection

- Carnegie originally looked at BOP fluids due to volumes
- BOP fluids have limited lifespan.
- MacDermid offered Erifon CLS (robust, neat, oil replacement) due to many advantages
- Due to high system volumes required this was still too expensive
- Erifon WECS (Wave Energy Conversion System) concentrate was developed.
Erifon WECS

• Control fluid quality
  – Proven technology adapted to application
  – Supplied as concentrate
• Environmental Performance
  – Stable yet robust
  – High biodegradability and low toxicity
• Key Chemical Properties
  – Liquid corrosion inhibition
  – Vapor phase corrosion inhibition
  – Tolerant to seawater contamination
• Ideal properties for energy transmission
  – Density higher than seawater
  – Low compressibility
How many Megawatts?

• Adopting proven fluid technologies may advance successful ocean energy conversion
  – Carnegie Plan is for a 20MW plant
  – Followed by plans for 100MW expansion