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Recommended Practice

Elastomer Classification and Characterization

Ver 1.0

PCP Run Life Improvement JIP
Participants

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ACKNOWLEDGEMENTS

C-FER would like to acknowledge the contribution of the JIP Participants and PCP vendors in the development of this Recommended Practice. PCP Vendors include:

- Dyna-Drill Technologies
- Kudu Industries Inc. / PCM
- National Oilwell Varco
- NETZSCH Oilfield Products
- R&M Energy Systems
- Tierra Alta
- Weatherford Artificial Lift

FOREWORD

The objective of this Recommended Practice is to provide a common terminology for the classification and characterization of PCP elastomers, for use within the PCP RLI Joint Industry Project, based on information commonly reported by PCP vendors to their clients.

There are currently no industry standards for the classification and characterization of elastomers for PCP applications. However, the topic is under discussion by an ISO sub-committee (ISO 15136.1 – Petroleum and natural gas industries – Downhole equipment – Progressing cavity pump systems for artificial lift – Part 1: pumps), and a draft of this standard may be released late in 2007. As much as possible, the classifications and elastomer characteristics used in this Recommended Practice have been aligned with the ISO standard where appropriate. This will reduce the amount of future work needed to make the PCP RLI project compliant with the ISO standard once it is completed.

For a review of information anticipated to be included in the ISO standard, see Appendix A. For further detail on the information provided by the vendors, specific values and descriptors reported, and a translation of those descriptors and values into the adopted classifications and characteristics used in this Recommended Practice, see the C-FER Report: Classification and Characterization of Selected Elastomers, which was issued in conjunction with this Recommended Practice.

1. SCOPE

Elastomer selection plays a key role in obtaining reasonable run-lives of progressing cavity pumps (PCPs) when producing a wide range of fluids. Elastomers are known to be particularly sensitive to the presence of aromatics, H₂S, CO₂, water and high temperature.

In an effort to understand how elastomer properties affect pump run-life for a given set of operating conditions, elastomer properties must first be tracked and included in the Progressing Cavity Pumping Run-Life Improvement (PCP RLI) database for analysis, through investigations such as the following:

- Differences in elastomer selections by different operators
 - What elastomers are operators using in various applications? What type, or with what main characteristics?
- Relation of pump performance to elastomer type and application characteristics
 - Is one elastomer type or are elastomers with certain characteristics outperforming others in specific applications?

It is acknowledged that vendors may have different methods for determining reported properties or characteristics. Methods for testing, evaluating and determining elastomer characteristics are not covered by this Recommended Practice.

2. ELASTOMER CLASSIFICATION AND CHARACTERISTICS

2.1 Adopted Elastomer Classifications and Characteristics

Based on information provided by the vendors and recommendations carried forward to the Steering Committee (SC), in the PCP RLI JIP, the classifications and characteristics listed in Sections 2.1.1 and 2.1.2 are used for describing elastomers in the project database.

Appendix B contains a sample table which may be used for recording this data for a group of elastomers.

2.1.1 Classifications

- Elastomer Name – a unique name given by the pump manufacturer to distinguish among elastomers within the same elastomer type.
- Elastomer Type – Six groups are used:
 1. Medium ACN NBR – includes nitrile butadiene rubbers or nitrile rubbers (NBR) with acrylonitrile (ACN) content $\leq 35\%$
 2. High ACN NBR – includes NBRs with ACN content $> 35\%$
 3. Medium ACN HNBR – includes highly or fully-saturated hydrogenated nitrile rubbers (HNBR) with ACN content $\leq 35\%$
 4. High ACN HNBR – includes HNBRs with ACN content $> 35\%$
 5. FKM – fluorocarbon elastomers
 6. Other

2.1.2 Characteristics

- General Description – (free format) information provided by the pump vendor.
- Temperature Limit – a single value. This should represent the maximum temperature normally recommended for the elastomer.
- Chemical Resistance – Resistance to each of the following substances are rated:
 - H₂S
 - CO₂
 - Aromatics
 - Water

The following five qualitative descriptors are used for rating chemical resistance:

1. Excellent
2. Good
3. Average

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4. Fair
5. Poor

- Mechanical Properties

- Wear Resistance – The following five qualitative descriptors are used:
 1. Excellent
 2. Good
 3. Average
 4. Fair
 5. Poor
- Hardness (Shore A) – a single value. When a range is provided by the pump vendor, the median value of the range is used.

Note: This Recommended Practice is not prescriptive in how vendors should determine each of the five qualitative descriptors for Chemical and Wear Resistance. Vendors may rank their own products in terms of their relative performance without considering how their elastomers compare to those of other vendors.

APPENDIX A – REVIEW OF ISO 15136-1

Review of ISO Elastomer Classifications and Characteristics

The ISO sub-committee tasked with reviewing ISO 15136-1 for progressing cavity pumps is comprised of representatives of many stator manufacturers (including PCM, Netzsch, Centrillift, R&MES and Weatherford) and operators (ConocoPhillips, Exxon Mobil, Total, Shell, Petrobras, Ameriven and Husky). The new version of the ISO document may include standard methods and nomenclature for classifying and characterizing elastomers.

Information regarding classifications and characteristics currently being discussed by the sub-committee are included in this Recommended Practice as background information and to provide reasoning as to why certain classifications and characteristics have been adopted in this Recommended Practice. As an official draft of the ISO 15136-1 standard had not been released when this Recommended Practice was written, this information may not reflect the contents of the final ISO Standard when it is released.

Classifications

The following is a list of classifications proposed to be used by the ISO sub-committee:

- Nitrile elastomer (NBR)
 - Medium: ACN content $\leq 35\%$
 - High: ACN content $\geq 36\%$
 - Note: other compound characteristics, besides ACN content, determine elastomer performance
- Hydrogenated nitrile elastomer (HNBR)
 - Medium: ACN content $\leq 35\%$
 - High: ACN content $\geq 36\%$
- Fluoro elastomer (FKM)
- Other

Characteristics (Specifications)

The following is a proposed list of characteristics, termed specifications by the ISO sub-committee, for use in the standard:

- Mandatory information (should be available to users) based on standard test procedures

Appendix A – Review of ISO 15136-1

- Oil and chemical resistance
 - Water and IRM 903 immersion (mass, volume, hardness, tensile strength changes)
- Mechanical Properties
 - Hardness (reporting on instantaneous and 10 second delays)
 - Service Temperature Limits (varies according to exact elastomer formulation and processing conditions, and for specific application parameters)
- Optional information based on recommended test procedures
 - Crude oil resistance
 - Mechanical properties variation with aging
 - Tear strength, abrasion resistance, compression modulus
 - Explosive decompression resistance
 - Compression set
 - H₂S resistance
 - Dynamic properties
 - Bond retention

APPENDIX B – SAMPLE TABLE

| Vendor | Elastomer Name | Elastomer Type (ACN Level) | General Description and Application | Temperature Limit (°C) | Chemical Resistance | | | | Mechanical Properties | | Other Comments |
|--------|----------------|----------------------------|-------------------------------------|------------------------|---------------------|-----------------|-----------|-------|-----------------------|--------------------|----------------|
| | | | | | H ₂ S | CO ₂ | Aromatics | Water | Wear Resistance | Hardness (Shore A) | |
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Table B.1 Sample Elastomer Data Table