The Aging of PA-11 and PA-12 in Offshore Flexible Pipes

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The Aging of PA-11 and PA-12 in Offshore Flexible Pipes

1 Scope

In the construction of a flexible pipe, an inner polymeric pressure sheath is the only layer which seals the conveyed fluid within the pipe structure. Therefore, its integrity is crucial to safe and reliable operation. Polyamide 11 (PA-11) has been the most commonly used pressure sheath material since the 1970s [1], other options being polyvinylidene fluoride and polyethylene. Another Long Chain Polyamide was introduced in 2006, Polyamide 12 (PA-12).

As polyamides suffer from chemical aging, understanding and assessing its aging process is a key part of flexible pipe design and associated integrity management.

NOTE PA-11 and PA-12, that are long chain polyamides (LCPA) are distinguished from the technically common short chain polyamides (SCPA) like PA-6, PA-6.6 or PA-6.12 types by the low carbonamide group density, such as: low water absorption capacity, therefore very good dimensional stability at different ambient humidity and physical properties which are not dependent on the water content, excellent stress cracking resistance even when exposed to chemicals, excellent impact and notched impact strength at low temperatures.

This document provides comprehensive guidance on materials and pipe issues regarding the use and operation of PA-11 and PA-12 in flexible pipe applications, typically in production and gas handling applications up to 100 °C.

The document focuses on the use of PA-11 in the internal sheath of flexible pipes, although similar considerations may also apply to other uses of PA-11 within flexibles, e.g., anti-wear layers, intermediate sheaths and outer sheaths.

The content of the First Edition of API 17TR2 has been modified for the use and evaluation of PA-12 accordingly. This revision of the API 17TR2 also refers to a report [14] which presents the results of the QPA Flex JIP that was performed during 2014 to 2020, with focus on reevaluation and correlation of established aging behavior. The quantification is based on extensive experimental work.

As addressed by API 17J, the collective goal of this document is to prevent failure of the internal pressure sheath, as a result of chemical aging and associated loss of mechanical properties, by determining and disseminating the necessary scientific and practical information. API 17J and 17B contain only limited information with respect to these phenomena, and this report supplements the recommendations provided in API 17B.

PA-11 is also used in umbilicals. However, the exposure temperatures are frequently lower than production temperatures. In cases of higher temperature exposure, the information contained in this document applies.

From this point on this document only applies to PA-11 and PA-12 grades.

2 Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

API Recommended Practice 17B, *Recommended Practice for Flexible Pipe, Sixth Edition, 2024*

API Specification 17J, *Specification for Unbonded Flexible Pipe, Fifth Edition*

API Specification 17K, *Specification for Bonded Flexible Pipe, Third Edition*

ASTM D2857-95, *Standard Practice for Dilute Solution Viscosity of Polymers. Relative viscosity determined by this practice is not equivalent to those determined by ASTM D789*