Internal linings

Selection variables and their link to design standards

Simon Daly,
Oil, gas & thermal power segment manager

Biography

Simon Daly

Group Oil, gas & thermal power segment manager
Hempel A/S, Denmark

Represents Hempel:

- ISO TC 67 WG 11
- ISO TC 67 WG 11 TG3 : ISO 18796-2
- JIP 33 SL 35 External stakeholder group
- IOGP Coating sub-committee

Linings History

- 1989 – 1993 Vinyl Ester development
- 1994 - 2000 High Temperature Epoxy Novolac development (Belzona)
- 2000 – 2004 High Temperature Epoxy field support and sales (Current)
- 2008 – 2010 Ceilcote integration and linings offer development (AkzoNobel)
- 2019 Linings standard development (ISO 18796-2)

Linings Environment

	Storage tanks	Process tanks	Pressure vessels	Containment areas
Range of compositions	**Limited**	**Wide**	**V. Limited**	**Wide**
Temperature range	**Limited**	**Limited**	**Wide**	**V. Limited**
Pressure range	**V. Limited**	**V. Limited**	**Wide**	**V. Limited**
“Complicating” factors	**V. Limited**	**V. Limited**	**Wide** (Mechanical)	**Wide** (Substrate)

Question 1

Which of the following variables would you suggest is the most important to consider when specifying an internal lining?

A Fluid composition

B Temperature

C Pressure & gas composition

D Complicating factors
(e.g. abrasion, potential for impact damage, resistance to cleaning, impact)

Question 2

Which of the following variables would you consider first when specifying an internal lining?

A Fluid composition

B Temperature

C Pressure & gas composition

D Complicating factors
(e.g. abrasion, potential for impact damage, resistance to cleaning, impact)

Linings Environment

	Storage tanks	Process tanks	Pressure vessels	Secondary containment
Range of compositions	**Limited**	**Wide**	**V. Limited**	**Wide**
Temperature range	**Limited**	**Limited**	**Wide**	**V. Limited**
Pressure range	**V. Limited**	**V. Limited**	**Wide**	**V. Limited**
“Complicating” factors	**V. Limited**	**V. Limited**	**Wide** (Mechanical)	**Wide** (Substrate)

Linings Environment

Typical storage terminal lined opportunity > 75,000 m²

Typical process train lined opportunity < 10,000 m²

Compare and contrast……..storage tank lining is easy (well relatively!)

Fluid Composition

Fluid composition

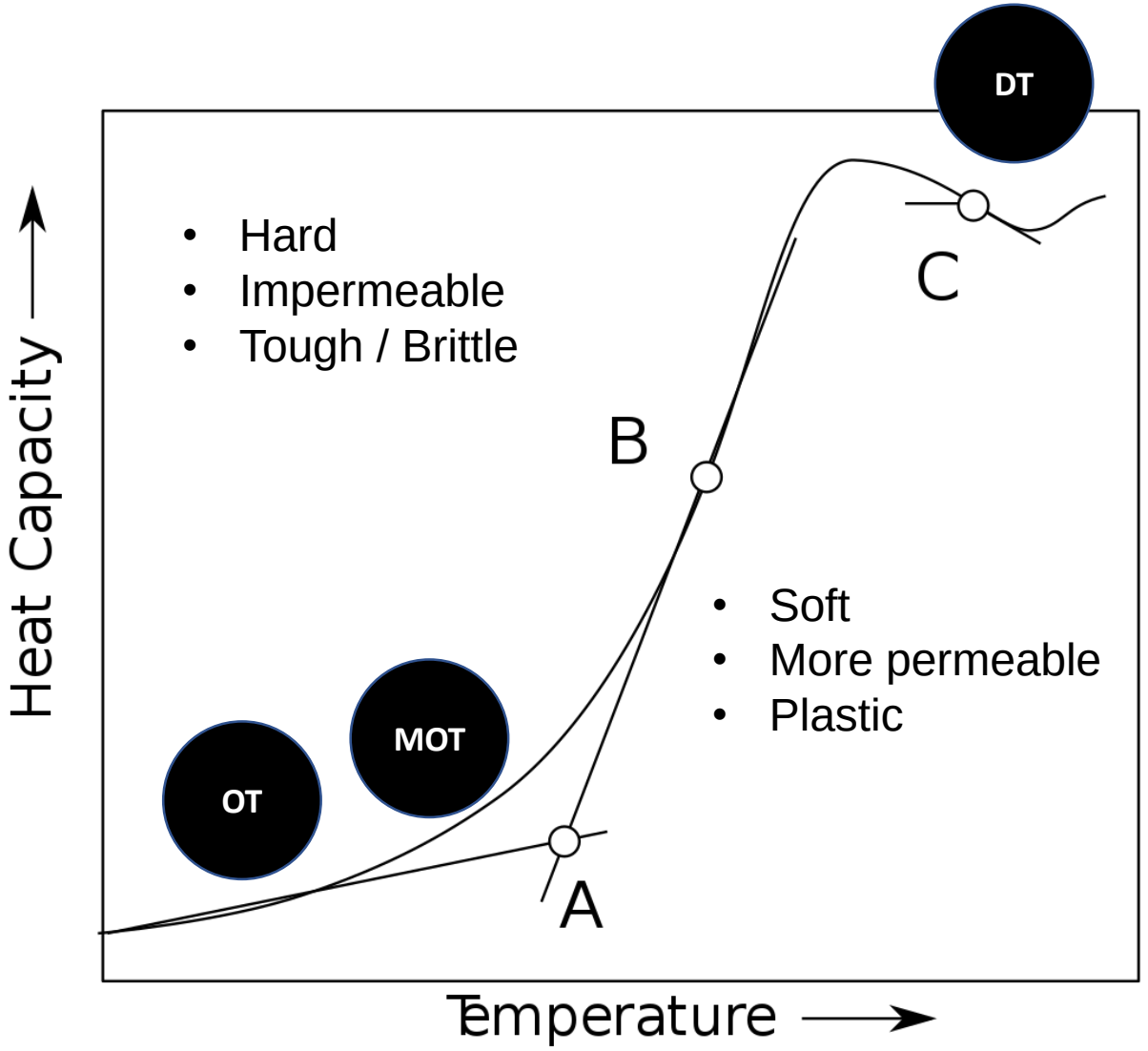
- Passive Aqueous / hydrocarbon (permeation)
- Reactive e.g. Strong H^+ (chemical attack)
- Ad hoc compositions
- Cleaning compositions (de-scalers)

Temperature

Temperature

- Which one?
- Most thermoset properties change with temperature
- Importance of softening (glass transition) point
  - Tg versus heat distortion
- Presence of temperature gradient (cold-wall)
  - Thermo-osmosis

Glass transition

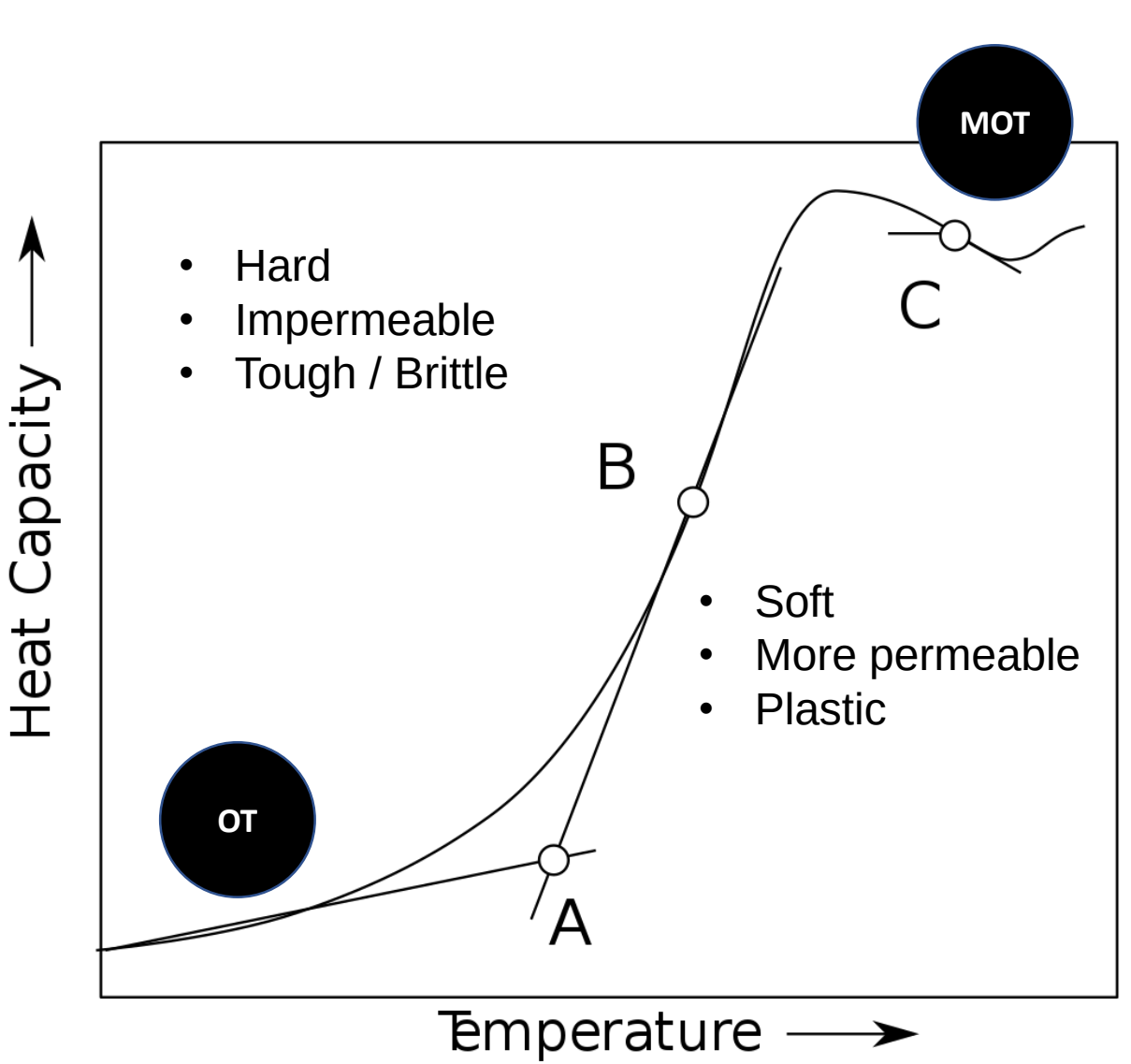


OT Normal Operating temperature

MOT Maximum operating temperature

DT Design temperature

Glass transition



OT Normal Operating temperature

MOT Maximum operating temperature

DT Design temperature

* Measurement is quite important

Question 3

Pressure - Which of the following variables has the most effect on coating performance?

A Gas composition & parcel pressure

B Total pressure

C Decompression rate

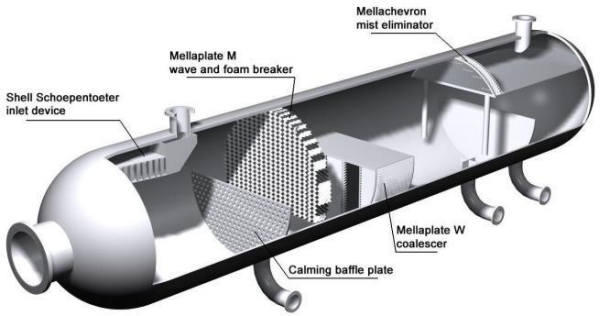
D All of the above or it depends?

Other factors

1. Liquid solids content
2. Abrasion
3. Impact resistance
4. Di-electric strength
5. Adhesion
6. Cathodic disbondment resistance
7. Substrate compatibility
8. Design…… and many more

Role of design

- Improved equipment design will aid coating success
- Bad design
  - Remains a major challenge
  - Lack of access
  - Inability to holiday test
  - Potential for mechanical damage
    - In service
    - During assembly



Standards

Guidance is increasingly available (but needs accelerating)

- **ISO 16961** – “Petroleum, petrochemical and natural gas industries-Internal protective coating and lining of steel storage tanks”
- **ISO 18796 - 1** : 2018 “Petroleum, petrochemical and natural gas industries-Internal Protective Coating and Lining of Process Vessels Part 1:Technical requirements.”
- **ISO DIS 18796** - “Part 2 - Internal lining of process pressure vessel – guideline on selection of coating and lining systems”

Other standards from other bodies are also available e.g. NACE, API etc

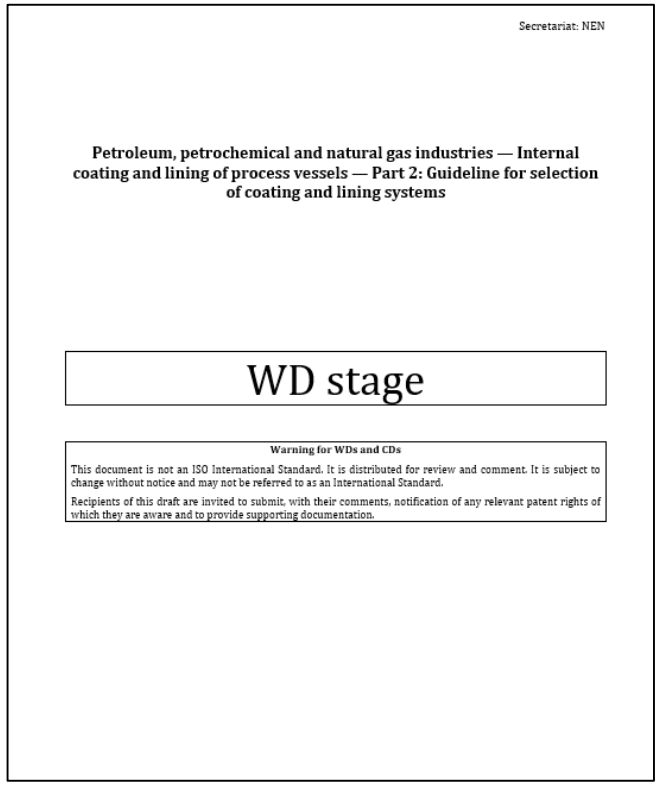
ISO DIS 18796-2

NORSOK M-501 Edition 6

Application (if not specified under others)	Surface preparation	Coating system
Internal surface of carbon steel tanks **Coating system no. 3A** Potable water tanks **Coating system no. 3B** Ballast water tanks/internal seawater filled compartments **Coating system no. 3C** Tanks for stabilised crude, diesel and condensate **Coating system no. 3D** Process vessels < 0,3 MPa < 75 °C **Coating system no. 3E** Process vessels < 7,0 MPa < 80 °C **Coating system no. 3F** Process vessels < 3,0 MPa < 130 °C **Coating system no. 3G** Vessels for storage of methanol, mono ethyl glycol etc.	Coating system no. 3A: Cleanliness: ISO 8501-1 Sa 2½ Roughness: ISO 8503 Grade Medium G (50 µm to 85 µm, R_{ys}) Coating system no. 3B: According to pre-qualification Other coating systems: As for coating system no. 3A or according to coating manufacturers recommendation.	Lining materials for carbon steel tanks are subject to special evaluation, and shall always be approved by the purchaser. As a minimum the following shall be evaluated: • medium; • operating temperature; • operating pressure; • experience with product; • properties with respect to explosive decompression.

- Quite prescriptive in terms of systems, but,
- No pre-qualification guidance

ISO DIS 18796 - 2



Secretariat: NEN

Petroleum, petrochemical and natural gas industries — Internal coating and lining of process vessels — Part 2: Guideline for selection of coating and lining systems

WD stage

Warning for WDs and CDs

This document is not an ISO International Standard. It is distributed for review and comment. It is subject to change without notice and may not be referred to as an International Standard.

Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

- Will combine evaluation of pre-qualification data
- And appropriate test methods

ISO DIS 18796-2

Guidance is given for the following:

- Key factors influencing coating and lining selection
- Principle test methods to be used as supporting evidence of performance when selecting suitable coatings and linings
- Typical coating and lining types and their suitability for certain environments
- Generic composition of test liquids which can be used as references when evaluating supporting evidence for coatings and linings
- Ensuring that supporting evidence used in evaluating coatings and linings is relevant to the potential end use

ISO DIS 18796-2

Design information

Testing Guidance (including pre-qualification)

Interpretation of test results

Documentation of results and evaluation

Appendices & supporting documentation

Summary

- Selection of linings needs to go beyond just “chemical” resistance
- Pressure vessels represent a particularly complex environment
- Better guidance is becoming available but in some cases “Vanilla”
  - Need to establish more robust pre-qualification framework
  - Create a process for pre-qualification not just a list of tests
- Designers have a very important role to play in successful internal lining

Any questions?

Simon Daly
Group Oil, gas & thermal power segment manager
Hempel A/S, Denmark
sida@hempel.com.uk