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Corrosion allowance in valves: common practice and new cost-effective approach to prevent failures

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Corrosion allowance in valves

Introduction

- **More and more demanding conditions (corrosive fluids, new refining process, ecc) for pressure containg equipment of pipelines and plants**
- **Need for very accurate material selection on the basis of fluids and operating conditions**
- **Guarantee service suitability and cost effectiveness**

Corrosion allowance in valves

Introduction

- **Corrosion allowance concept (CA)**
- **Usually added in case of carbon steel pipeline equipment or in any case to equipment dedicated to very severe applications**
- **Corrosion allowance is considered trade-off between corrosion resistance and cost effectiveness**

Corrosion allowance in valves

Introduction

Typical calculation procedure for equipment:

- **Minimum wall thickness by Standard Code (e.g. ASME B31.3, B31.8, BPVC, etc.)**

- **Addition of corrosion allowance**

$$t = \frac{PR}{S - 0.6P} + t_{CA}$$ (ASME BPVC VIII div. 1)

$$t = \frac{Pd_o}{2(FES_Y)} + t_{CA}$$ (ASME B31.4)

$$t = \frac{Pd_o}{2FETS_Y} + t_{CA}$$ (ASME B31.8)

$$t = t_{CA} + t_{th} + \left[\frac{Pd_o}{2(SE + PY)}\right]\left[\frac{100}{100 - T_{ol}}\right]$$ (ASME B31.3)

Corrosion allowance in valves

Introduction

- **Addition of corrosion allowance based on evaluation of corrosion rates to compensate the loss of material during service life:**

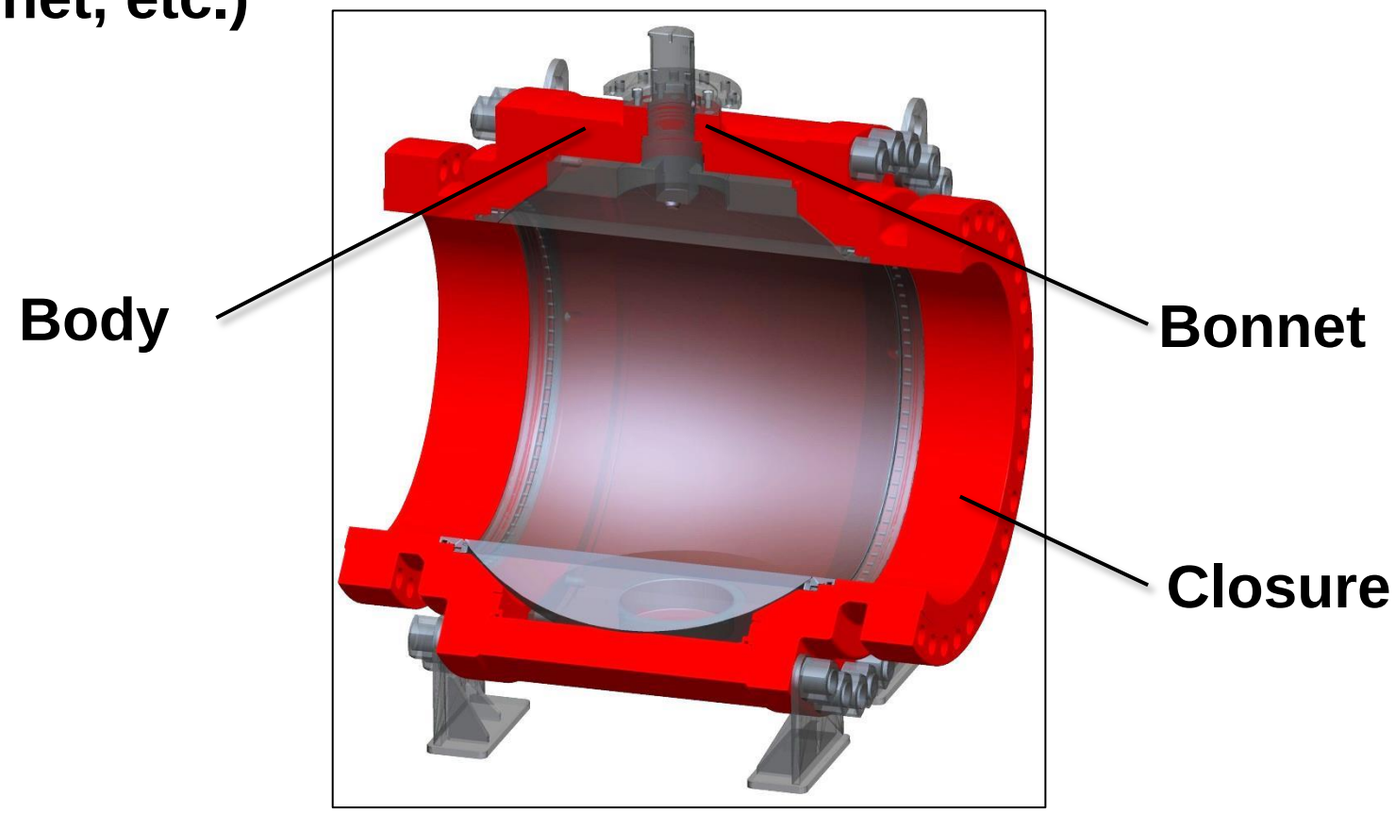
- **Expected service life**
- **Test results**
- **Literature data**
- **Good practice referred in similar applications**

$$Corrosion\ Rate = V_{cor} \cdot F_{scale} \cdot F_{h2s} \cdot F_{cond} \cdot F_{oil} \cdot F_{inhib} \cdot F_{glyc}$$

Corrosion allowance in valves

Corrosion allowance in Valves

- **Application of corrosion allowance to valve as piping components**
- **Corrosion allowance is required for pressure containing parts (Body, Closure, Bonnet, etc.)**

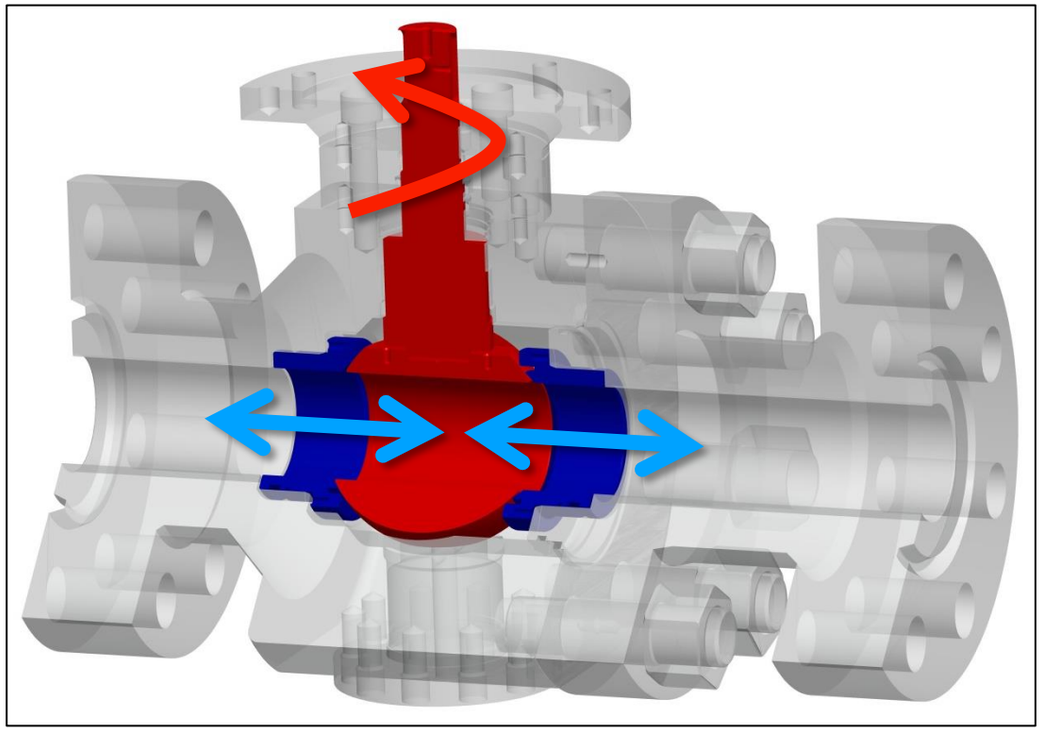


Corrosion allowance in valves

Corrosion allowance in Valves

- **Nevertheless valves present some peculiarities that must be carefully considered.**

- **They are not only elements designed to confine process fluid but they implement a sealing function and include moving parts.**



Corrosion allowance in valves

Corrosion allowance in Valves

Overview:

- **Body/bonnet joints**

Corrosion allowance in valves

Corrosion allowance in Valves

Overview:

- **Body/bonnet joints**
- **Stem sealing arrangement**

Corrosion allowance in valves

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Overview:

- **Body/bonnet joints**
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- **Seats movement**

Corrosion allowance in valves

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Overview:

- **Body/bonnet joints**
- **Stem sealing arrangement**
- **Seats movement**
- **Bushing housing**

Corrosion allowance in valves

Corrosion allowance in Valves

Overview:

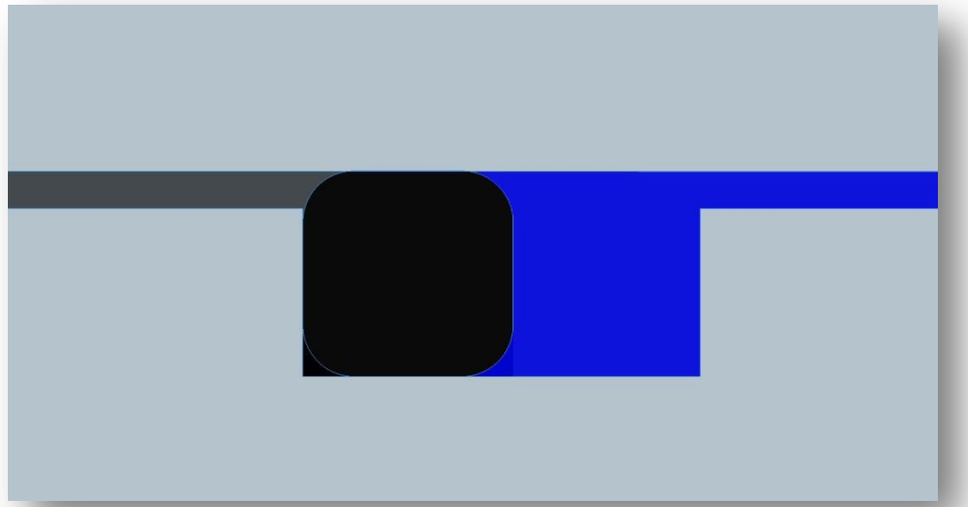
- **Body/bonnet joints**
- **Stem sealing arrangement**
- **Seats movement**
- **Bushing housing**
- **Body openings**

Corrosion allowance in valves

<u>Corrosion allowance in Valves</u>

Possible malfunctions:

Related to operating principle of seals
E.g. O-rings



Corrosion allowance in valves

Corrosion allowance in Valves

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Related to operating principle of seals
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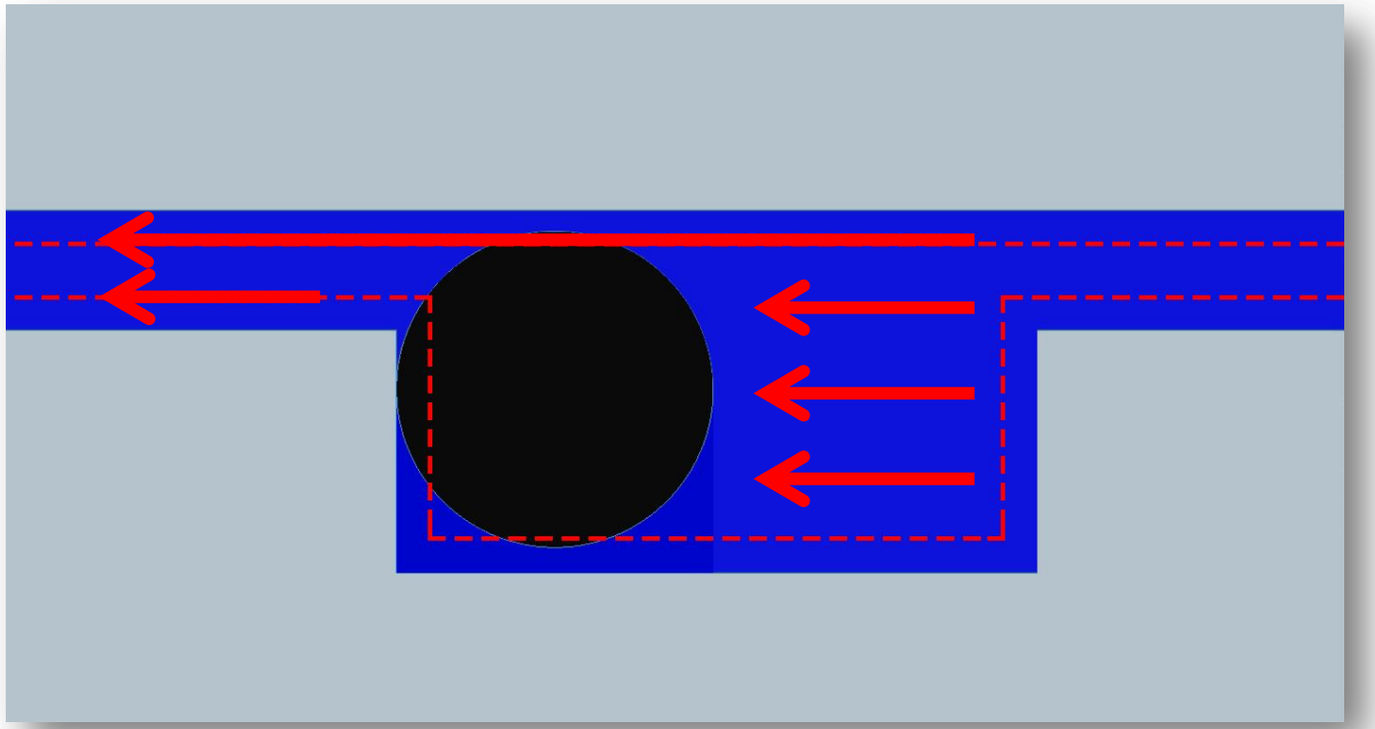

Corrosion allowance in valves

<u>Corrosion allowance in Valves</u>

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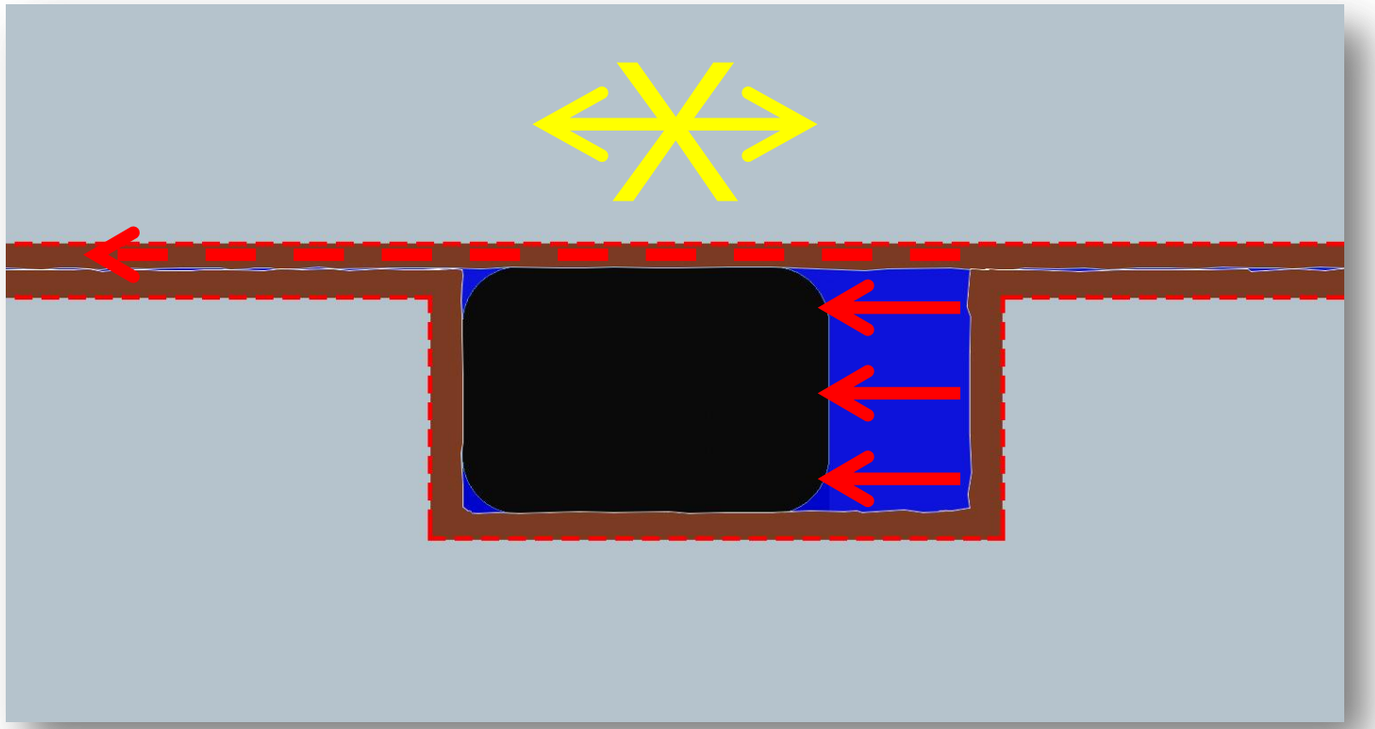

Corrosion allowance in valves

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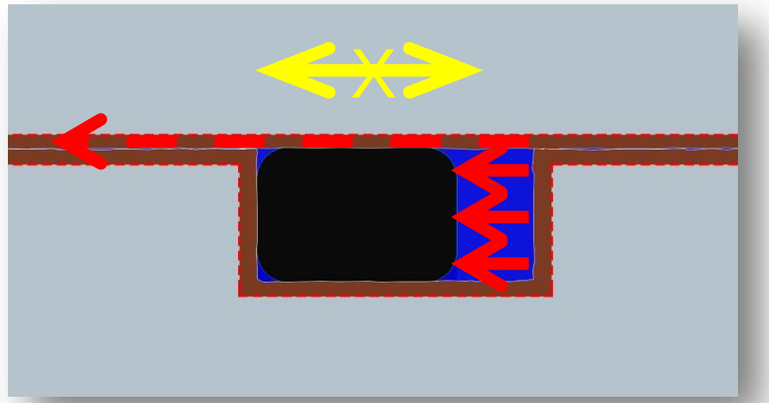


Possible malfunctions:

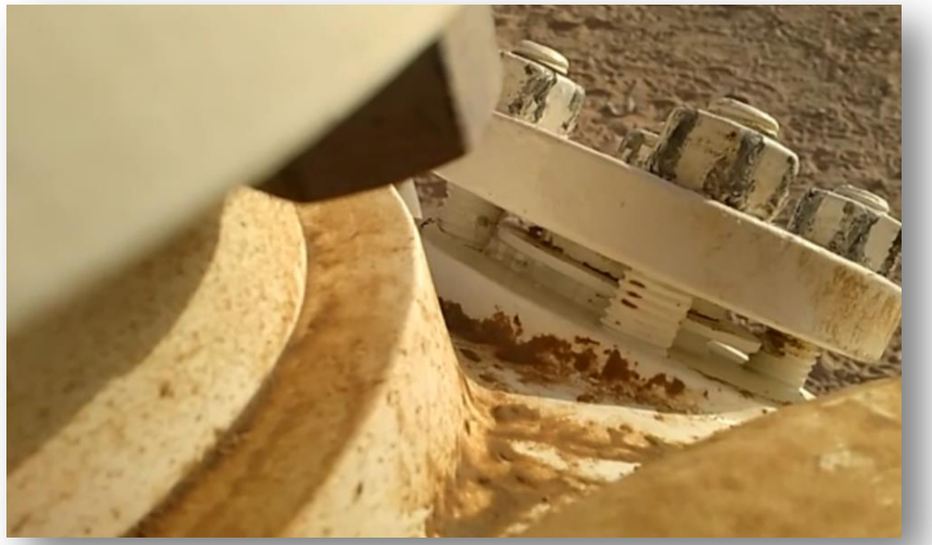
Related to operating principle of seals
E.g. O-rings

Corrosion allowance in valves

Corrosion allowance in Valves

Possible malfunctions:

- **In-line leakages (ineffective seat-to-body seals)**
- **Leakages to the environment (ineffective body seals)**



Corrosion allowance in valves

Corrosion allowance in Valves

Possible malfunctions:

- **Leakages to the environment (ineffective stem seals)**

Corrosion allowance in valves

Corrosion allowance in Valves

Possible malfunctions:

- **Torque increase, sticking of rotating parts (e.g. ball, stem)**

Corrosion allowance in valves

Corrosion allowance in Valves

- **Review of technical data by Sub-Suppliers (e.g. seals, bushings, etc.)**

- **Specific tests by Dafram R&D**

- **Validation of valves with dedicated solutions**

Corrosion allowance in valves

Corrosion allowance in Valves

Application of corrosion allowance in valves requires additional features:

- **CRA overlay on static sealing areas (body & bonnet seals)**

Corrosion allowance in valves

Corrosion allowance in Valves

Application of corrosion allowance in valves requires additional features:

- **CRA overlay on sealing areas (dynamic, stem seals)**

Corrosion allowance in valves

Corrosion allowance in Valves

Application of corrosion allowance in valves requires additional features:

- **CRA overlay on sealing areas (dynamic, seat-to-body)**

Corrosion allowance in valves

Corrosion allowance in Valves

Application of corrosion allowance in valves requires additional features:

- **CRA materials for body openings (e.g. drain port)**

Corrosion allowance in valves

Corrosion allowance in Valves

Special features applied to Case Studies:

Case 1: Trunnion side-entry ball valve 6’’ class 600

- **CRA SS (309L+316L)**
- **CRA Ni-alloy (Inc625)**

	CRA Material	Overlay	Bushing housing / body ports	COST IMPACT
CS body 3mm	-	-	CS	-
1.A	309L+316L	Sealing areas	316	
1.B	Inc625	Sealing areas	625	
1.C	309L+316L	All wetted	316	
1.D	Inc625	All wetted	625	

Corrosion allowance in valves

Corrosion allowance in Valves

Special features applied to Case Studies:

Case 2: Trunnion side-entry ball valve 24'' class 600

- **CRA SS (309L+316L)**
- **CRA Ni-alloy (Inc625)**

	CRA Material	Overlay	Bushing housing / body ports	COST IMPACT
CS body 3mm	-	-	CS	-
2.A	309L+316L	Sealing areas	316	
2.B	Inc625	Sealing areas	625	
2.C	309L+316L	All wetted	316	
2.D	Inc625	All wetted	625	

Corrosion allowance in valves

Corrosion allowance in Valves

Additional features applied to Case Studies: considerations

- **Valve functionality is guaranteed for _% additional cost at maximum**
- **Selection of CRA material should follow philosophy of trim material selection**
- **Actual valve design life can be sensibly increased**

Corrosion allowance in valves

Conclusions

- **Valves present some peculiarities that must be carefully considered**
- **Valves corrosion allowance is sometimes misused as only prevention of corrosion**
- **Malfunctions due to corrosion may occur**
- **Additional dedicated design features are necessary**
- **Cost impact is limited and should be considered (operational and maintenance overall costs to be evaluated)**

Thank you!

Do you have questions?

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