Management of MIC

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Internal pipeline corrosion

Internal pipeline corrosion

Bioclear – Microbial Analysis.

Field support

Identification & detection of (micro-)organisms

interpretation & modelling

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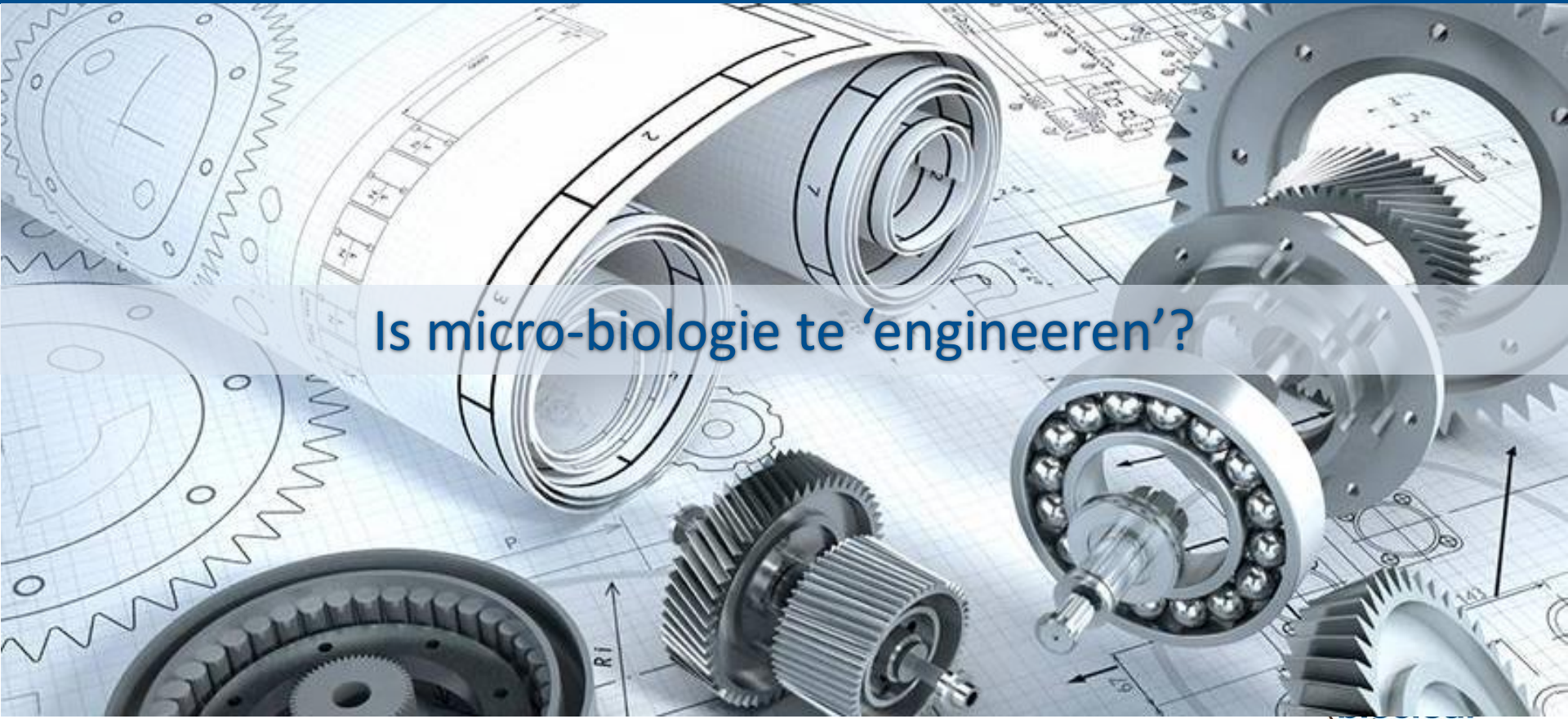
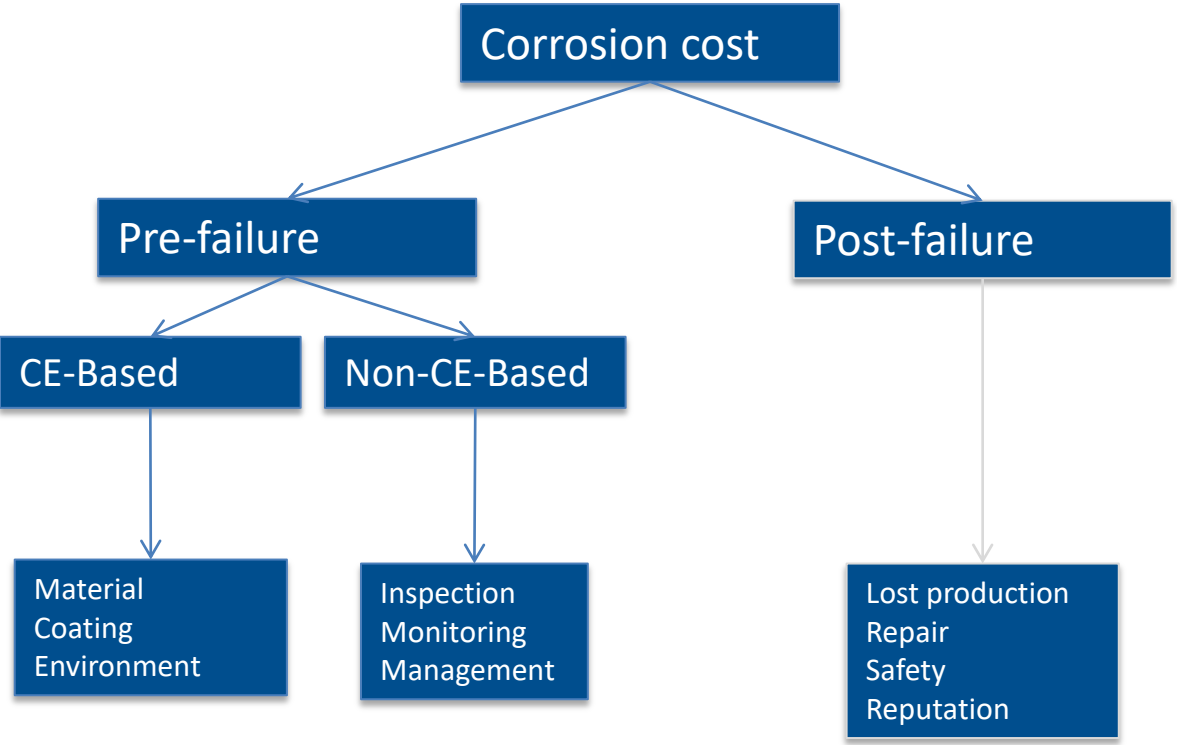
Is micro-biologie te ‘engineeren’?



Cost of corrosion



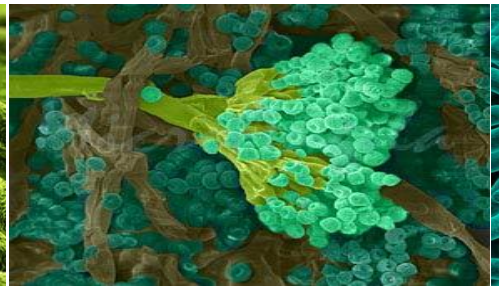
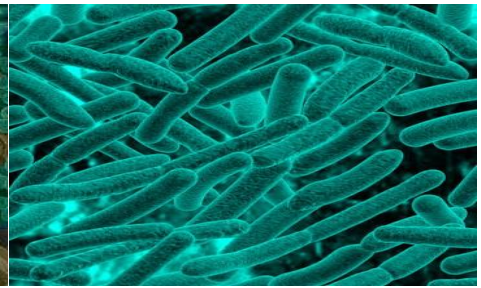
To support decision making
(managing risk, while optimizing CAPEX and OPEX)

MP March 2017, A. Morshed

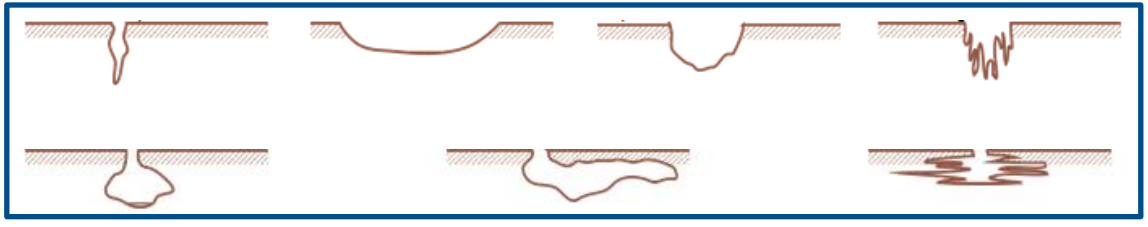
Effect of MIC

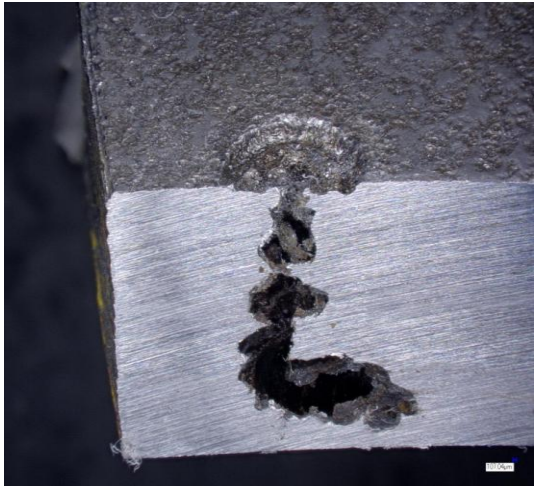
- De activity of micro-organisms can result into100 times faster material loss
- In ~ 50% of the corrosion failures, MIC is involved (source: NACE)
- within ~15% of the corrosion failures, MIC can be pointed as root cause

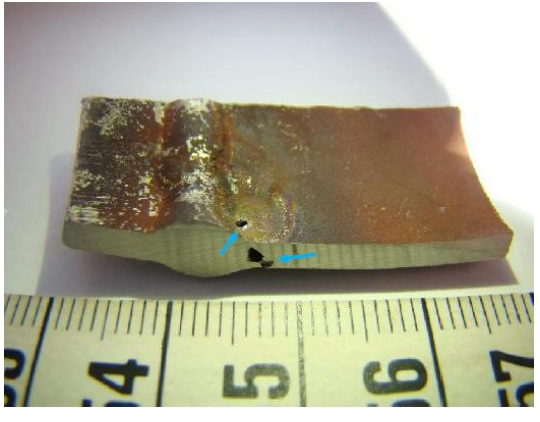
(source: own data)

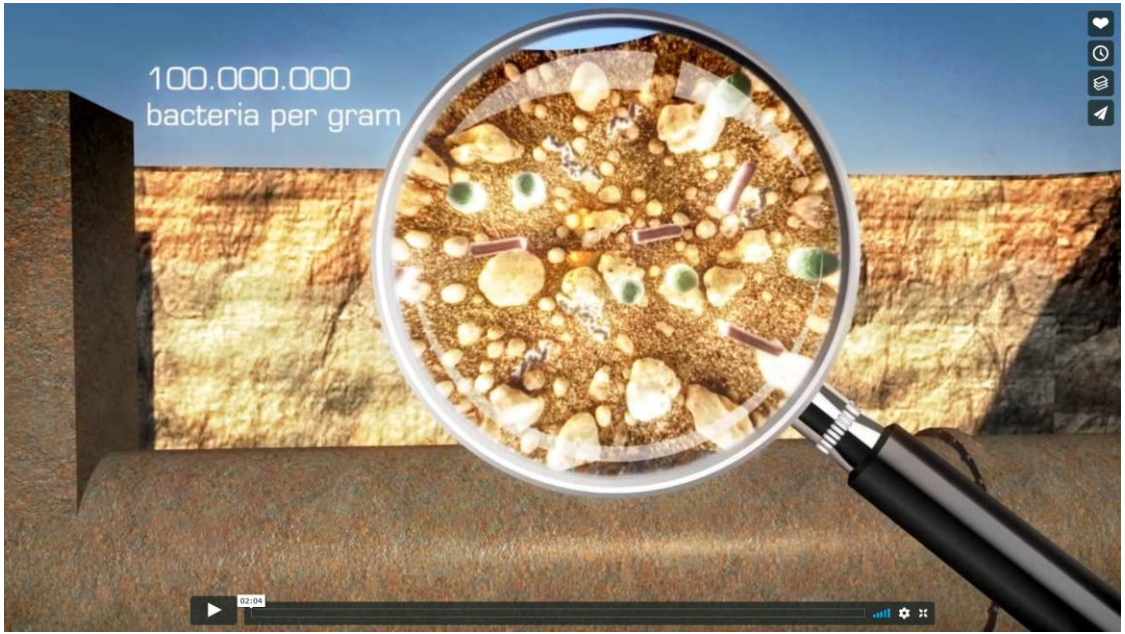
‘Indications’ for MIC







- https://vimeo.com/156411151



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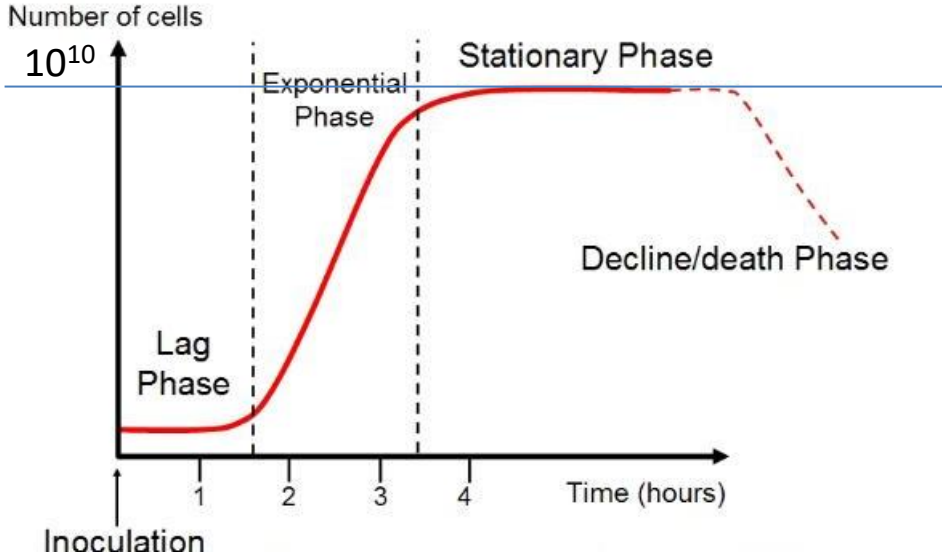
Common misconceptions

We zijn lineaire denkers



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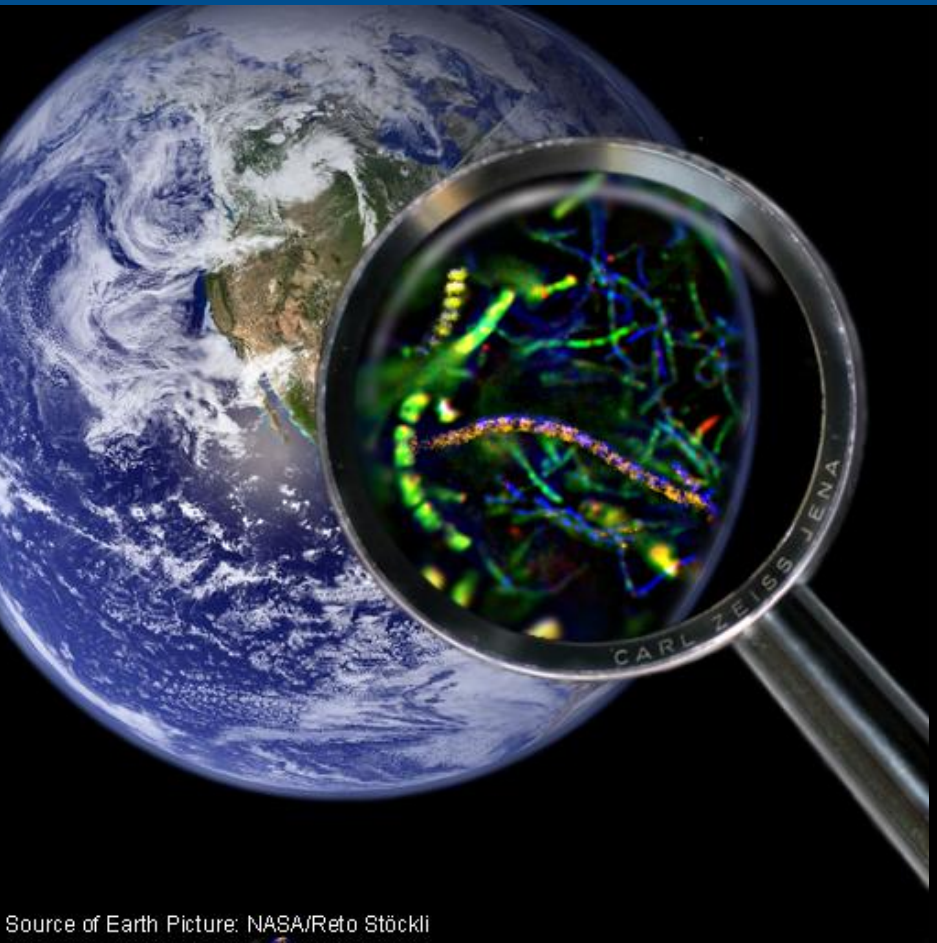
Example: Reduction of micro-organisms

Tested Bacteria Species	ATCC# Reference	Control CFU/carrier	1000ppm GA CFU/carrier	Reduction (%)
1. Clostridium perfringens	13124	5.3×10^5	ND*	>99.99
2. Enterobacter aerogenes	13048	6.1×10^4	ND	>99.99
3. Haemophilus parasuis	19417	4.6×10^4	ND	>99.99
4. Mycoplasma gallisepticum	15302	5.1×10^4	ND	>99.99
5. Mycoplasma synoviae	25204	1.7×10^5	ND	>99.99
6. Pasteurella multocida	8747	2.0×10^5	ND	>99.99
7. Salmonella enteritidis	13076	5.9×10^5	66	>99.98
8. Streptococcus suis	43765	9.1×10^4	ND	>99.99
9. Escherichia coli	8739	2.3×10^5	ND	>99.99
10. Salmonella pullorum	10398	4.7×10^6	ND	>99.99
11. Salmonella typhi	6539	3.0×10^5	ND	>99.99
12. Pseudomonas aeruginosa	15442	3.5×10^6	ND	>99.99
13. Staphylococcus aureus	6538	2.7×10^6	ND	>99.99
14. Klebsiella pneumoniae	4352	3.2×10^6	ND	>99.99

- 10^{10} X 0,01% = $10^{3=}$ 1.000 c/ml
- After 5 or 6 hours, back on initial numbers

Je bent nooit alleen



Source of Earth Picture: NASA/Reto Stöckli

Bacterial Life

Soil	Water	Air
10^8/gram	10^6/ml	10^3/m^3

Source of picture: 4ever.eu

Water, bron van leven

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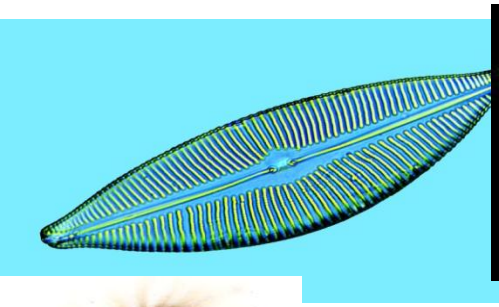
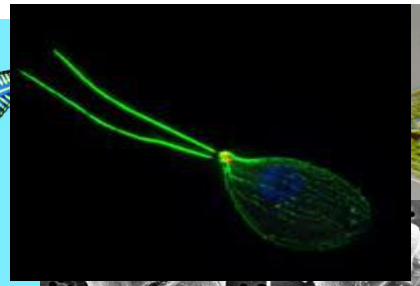
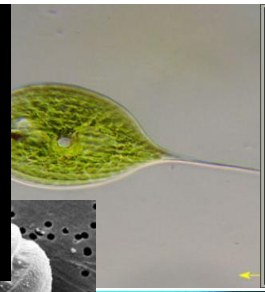
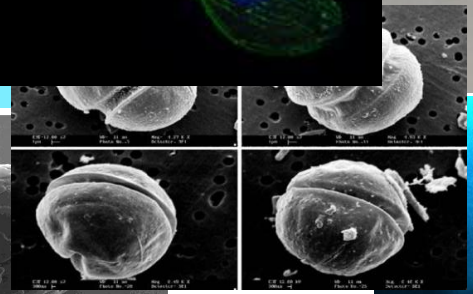
Domain	Organism	001_Ranking	002_Ranking	Difference
Bacteria	Gallionella capsiferriformans ES-2	1	17	16
Bacteria	Alicycliphilus denitrificans BC	2	5	3
Bacteria	Candidatus Nitrospira defluvii	3	10	7
Bacteria	bacterium B186(2011)	4	83	79
Bacteria	Methylovorus sp. MP688	5	38	33
Euk_Eencelligen	Tetrahymena thermophila	6	56	50
Euk_Eencelligen	Tetrahymena pyriformis	7	48	41
Bacteria	Polynucleobacter necessarius subsp. asymbioticus	8	79	71
Euk_Raderdiertjes	Adineta vaga	9	69	60
Bacteria	Variovorax paradoxus EPS	10	60	50
EukOverig	Arachis duranensis	11	16	5
Bacteria	Flavobacterium psychrophilum JIP02/86	12	54	42
Bacteria	Variovorax paradoxus	13	64	51
Bacteria	Burkholderia sp. CCGE1002	14	7	-7
EukOverig	Apis mellifera	15	65	50
EukOverig	Anopheles funestus	16	44	28
Bacteria	Shewanella putrefaciens 200	17	2	-15
Euk_Eencelligen	Naegleria gruberi	18	64	46
Bacteria	Burkholderia tropica	19	9	-10
Bacteria	Candidatus Rhabdochlamydia porcellionis	20	70	50
Bacteria	Burkholderia sp. CCGE1003	21	15	-6
Bacteria	Polynucleobacter necessarius subsp. necessarius STIR1	21	85	64
Bacteria	Polynucleobacter cosmopolitanus	22	85	63
Euk_Nematoden	Diploscapter sp. JU359	23		9999
Bacteria	Aeromonas bestiarum	24	26	2
Euk_Eencelligen	Placocista sp. CC-Grouse Mountain	25	46	21
Bacteria	Burkholderia rhizoxinica HKI 454	26	18	-8
Bacteria	Collimonas fungivorans Ter331	27	85	58
Bacteria	Shewanella baltica OS678	28	3	-25
EukOverig	Artemisia annua	29	85	56
Bacteria	Bdellovibrio bacteriovorus HD100	30	63	33
EukOverig	Daphnia pulex	31	64	33
Euk_Eencelligen	Heleopera rosea	32	73	41
Bacteria	Sideroxydans lithotrophicus ES-1	33	82	49
Euk_Eencelligen	Saprolegnia ferax	34	38	4
Euk_Eencelligen	Ichthyophthirius multifiliis	35	73	38
EukOverig	Solanum lycopersicum	36	13	-23

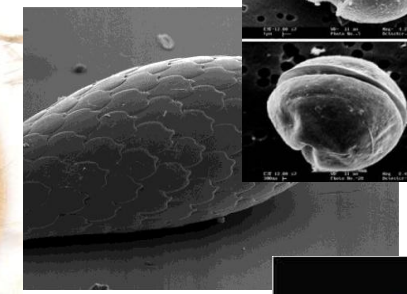
Name and blame, who are there?

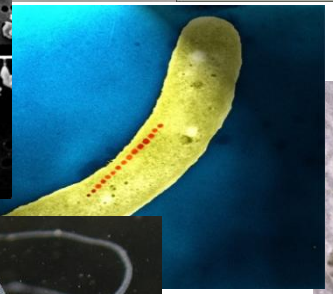


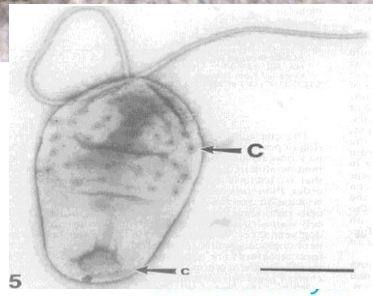




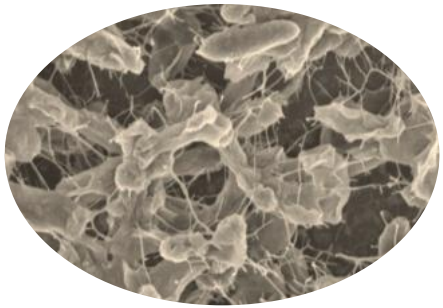


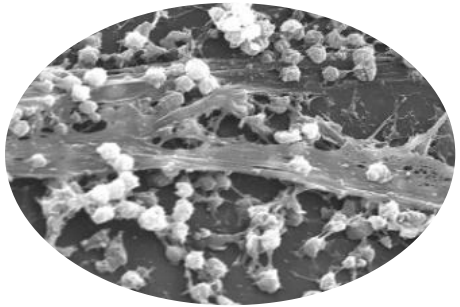


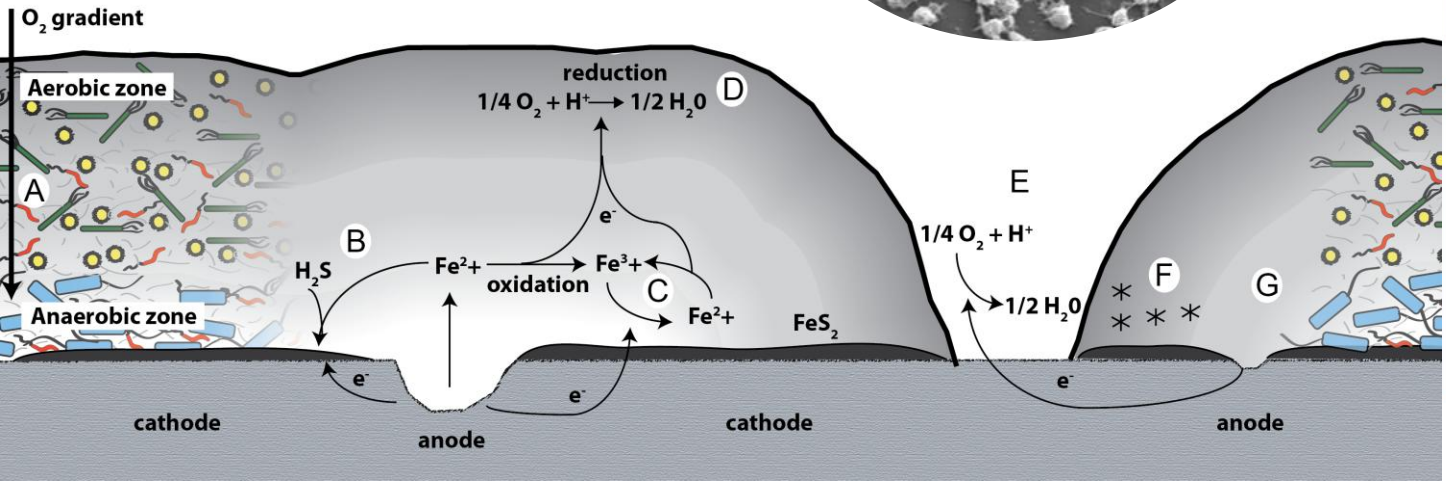


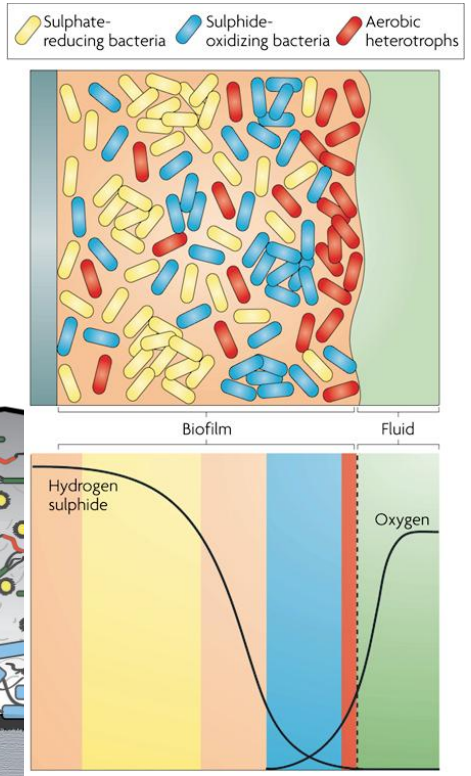


Biofilm









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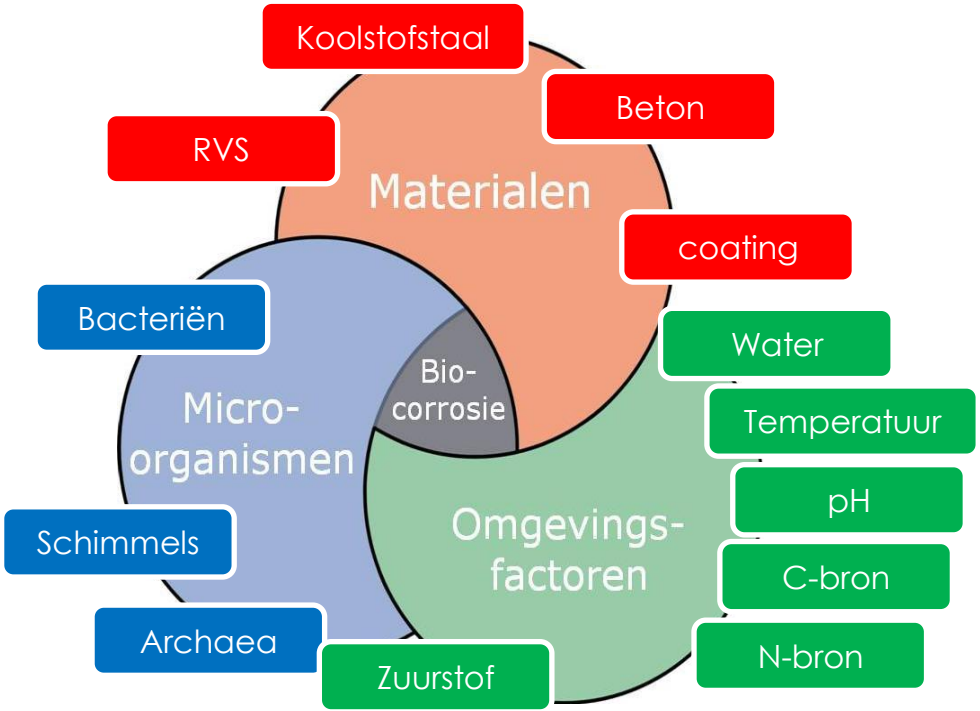
Checklist voor het vaststellen van MIC

- Morfologie:
  Putcorrosie? Biofilm? Kleur? Geur?
- Chemie:
  metabole producten aanwezig?
- Microbiologie:
  aanwezigheid van (actieve) micro-organismen

Temperatuur, pH, biocidegebruik, flow, chloriden(!)



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Hoe ondersteunt dit bij beslissingen?

Budgeting for capital expenditures is critical **future planning.** In deciding on a certain capital expenditure, a company's **management makes a statement** about its view of the company's current financial condition and its prospects for future growth. **It is also giving indications regarding what direction(s) it plans to move in the years ahead.** Capital expenditure budgets are commonly constructed to cover periods of five to 10 years, and therefore **can serve as major indicators regarding a company's "five year plan" or long-term goals.**

Management

Past

Present

Future

Financial figures

KPI's
Production
(activiteities)

Competences,
knowledge,
innovation

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Management van microbiologie, welke informatie?

Past

- Deposits,
- mineralogy,
- morfology

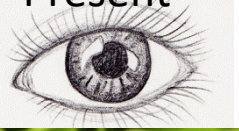
XRF

EDX

XRD

SEM

Present



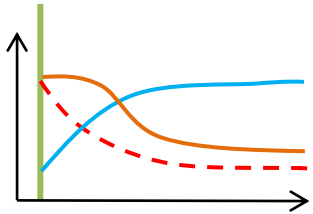
-Chemistry,
- Microbiology
- Fysiology

ATP

qPCR

NGS

Future



- Chemistry,
- Microbiology,
- Future conditions,
- Energy transfer

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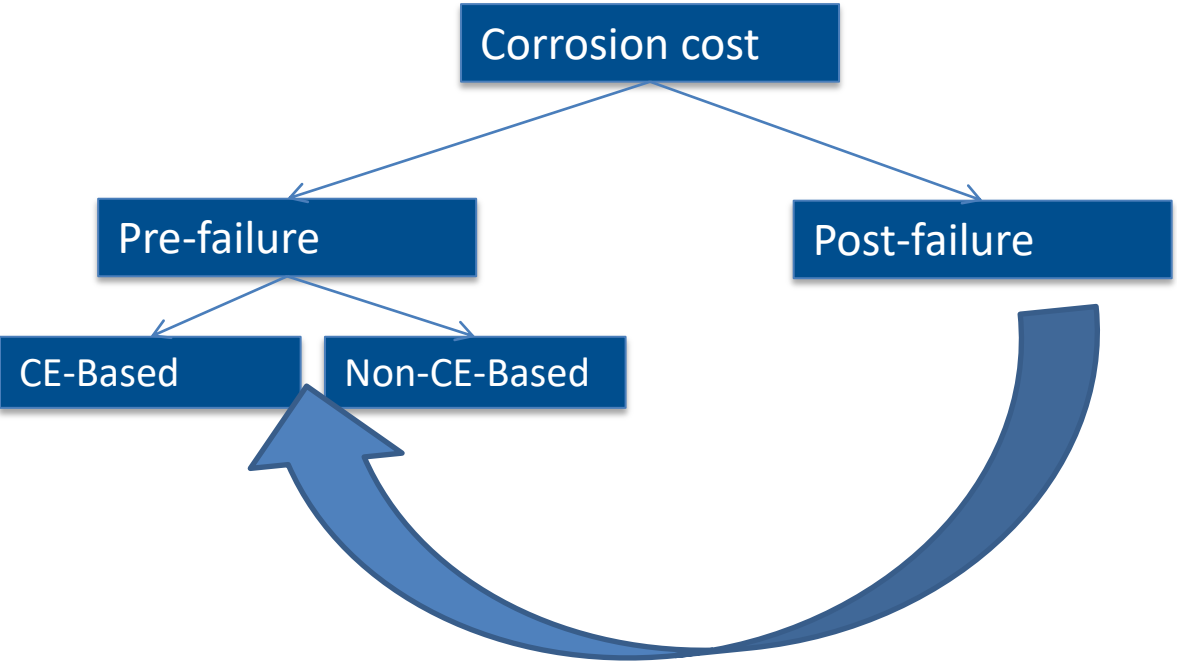
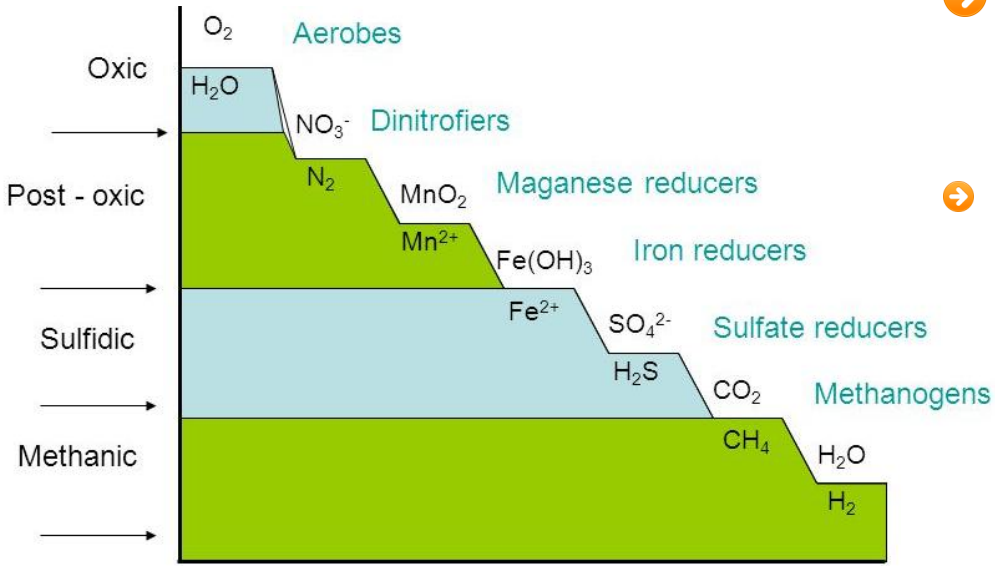
Cost of corrosion



Verschuiving naar Pre-failure

Quanitification of processes in time and space: Microbiology becomes an ‘engineering’ part

Redox potentiaal (Gibb's free energy)



- Simplified model of expected energy flux
  (holds in most cases)
- Unexpected activity and presence

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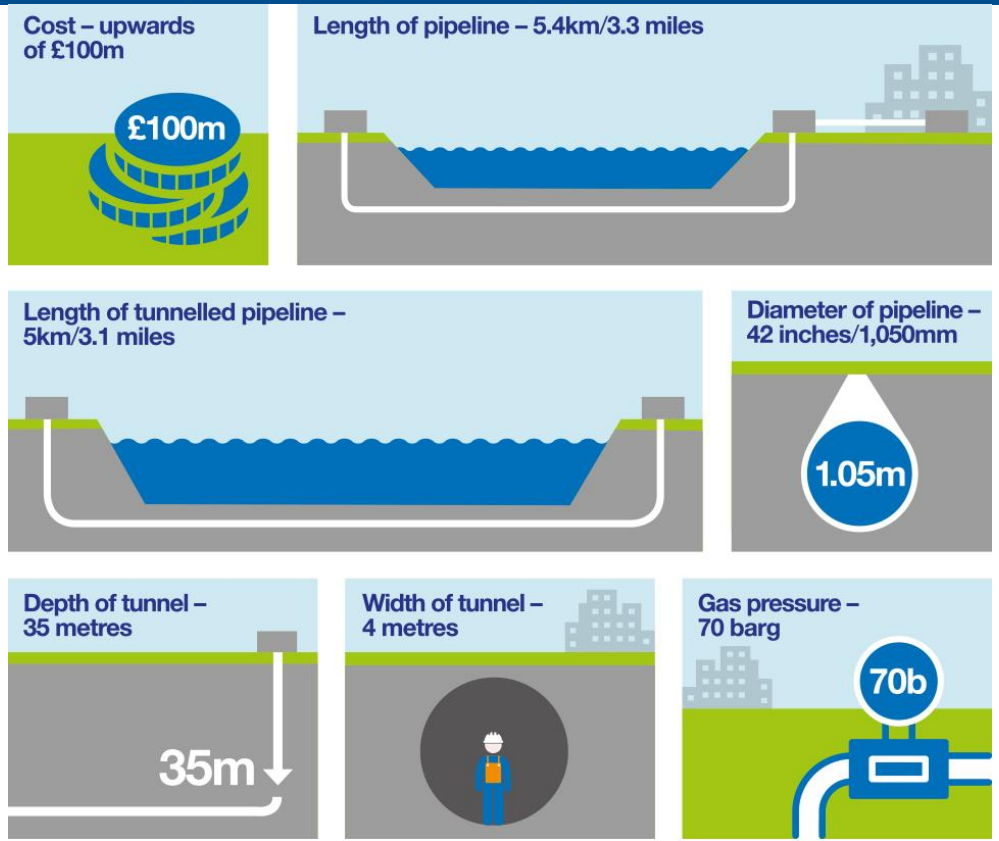
CASE: Ondertunneling rivier



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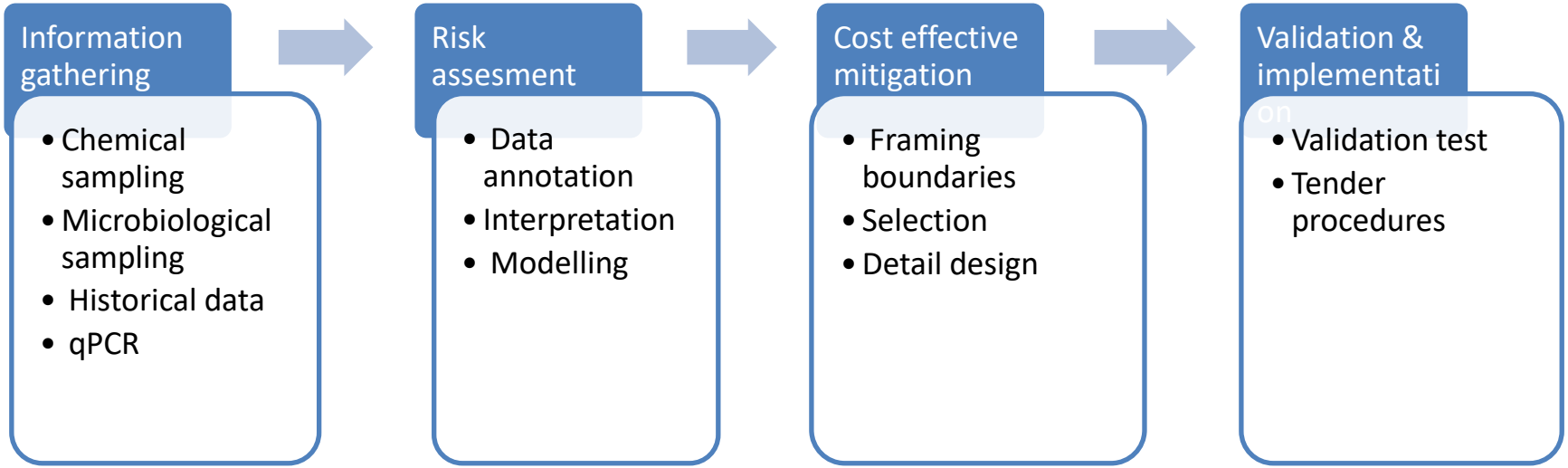

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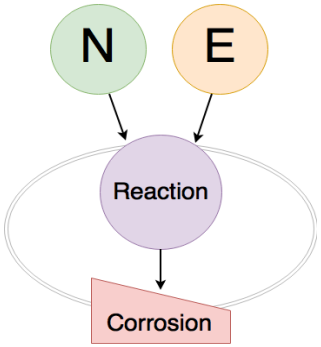
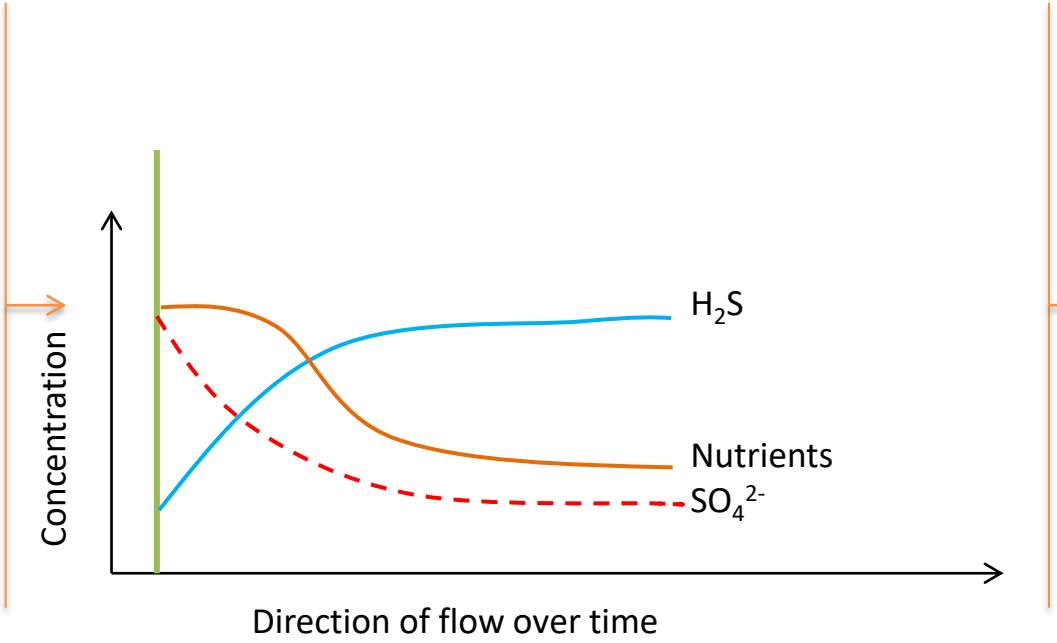
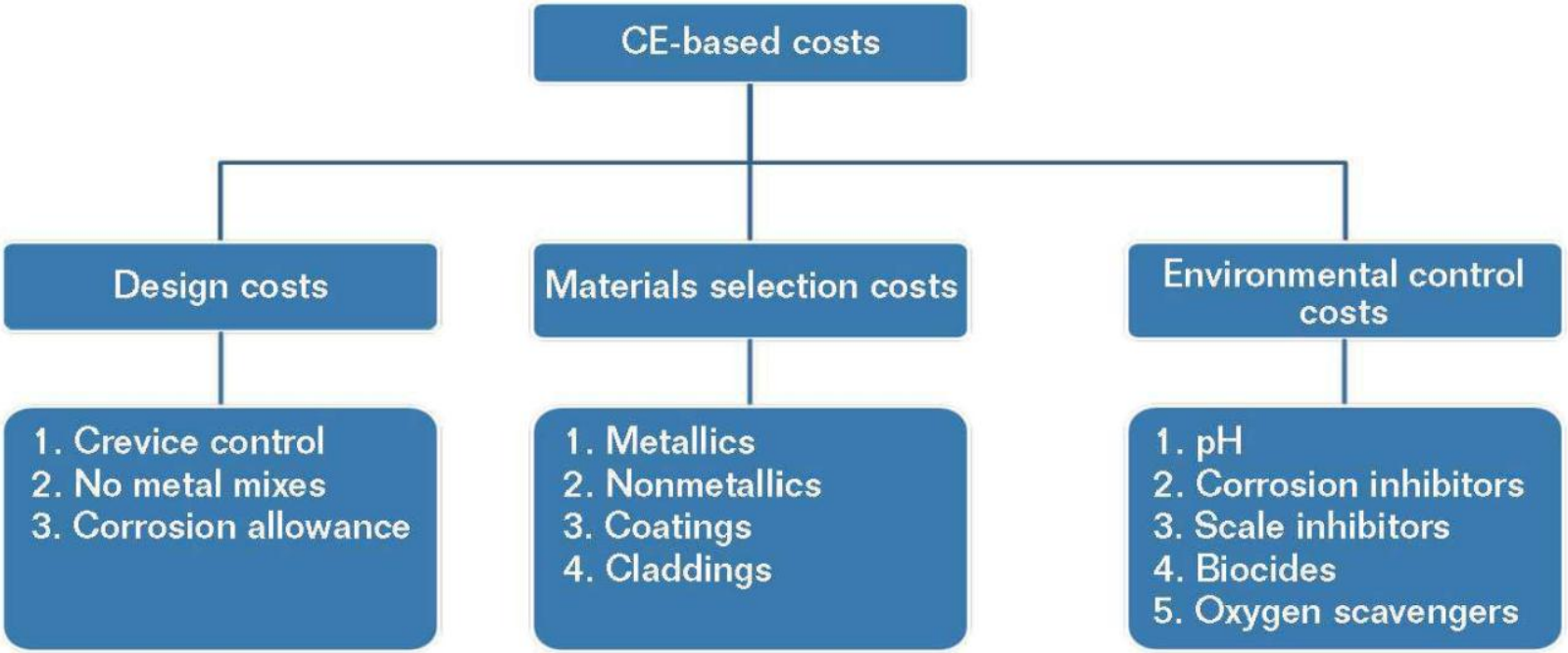
Humber river





Scenario's of material loss, through modelling of MIC



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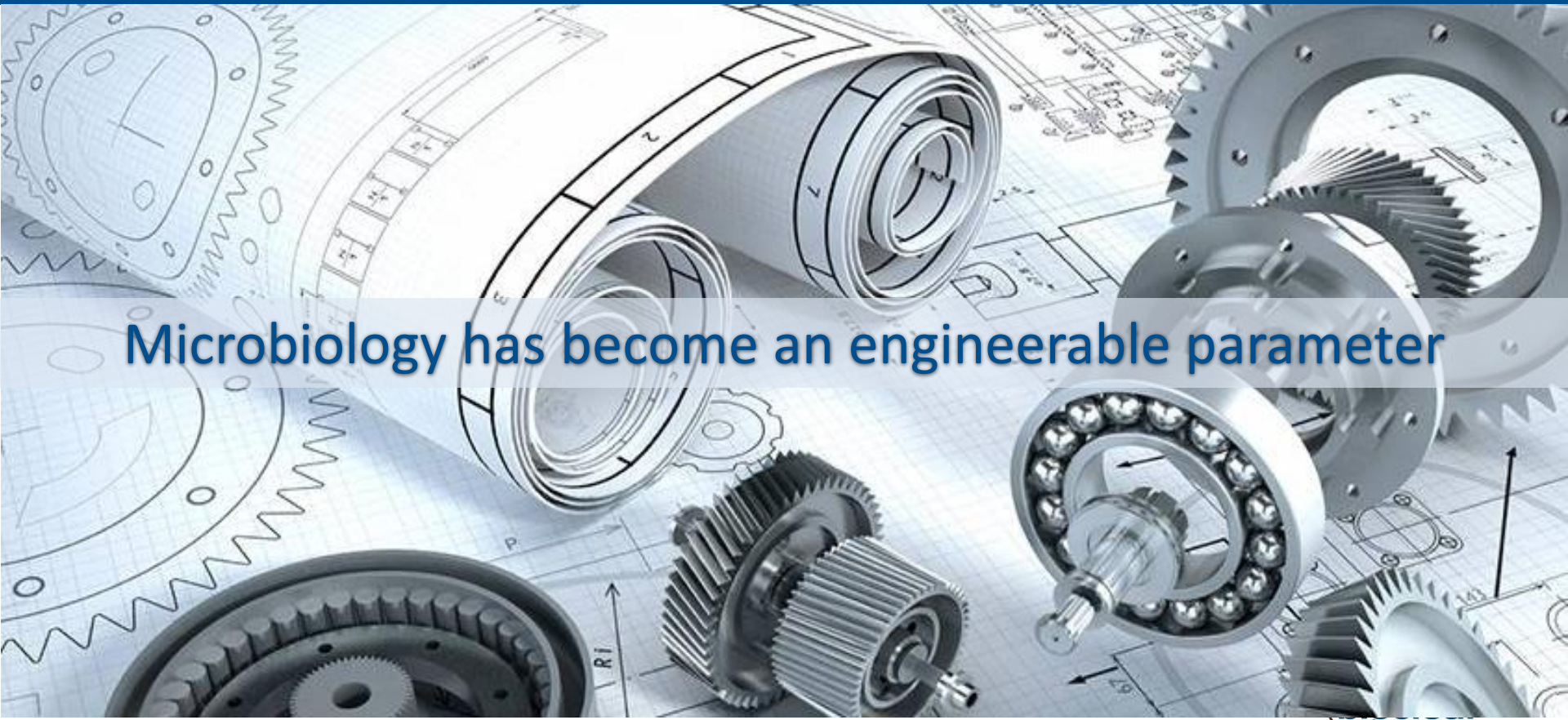
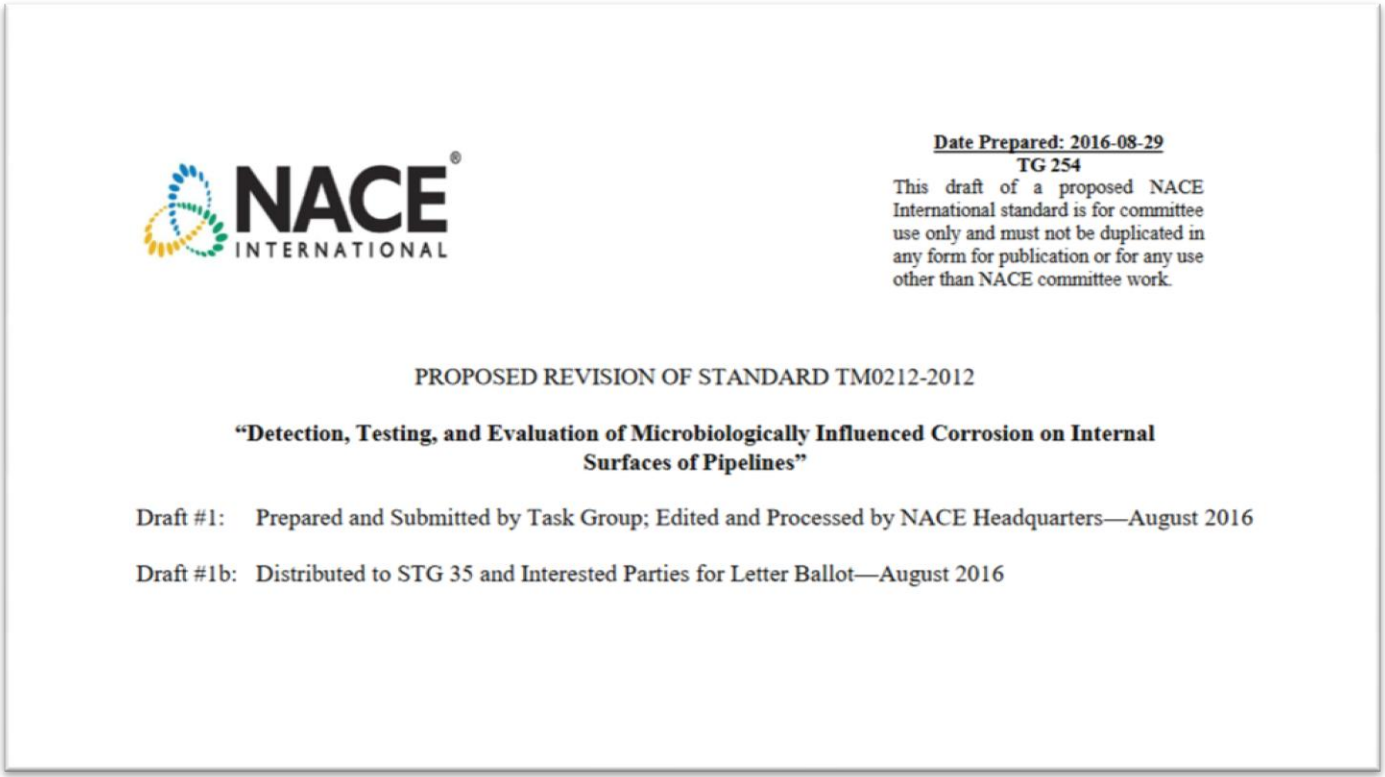


Microbiology has become an engineerable parameter

TM0212



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Date Prepared: 2016-08-29
TG 254
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PROPOSED REVISION OF STANDARD TM0212-2012

"Detection, Testing, and Evaluation of Microbiologically Influenced Corrosion on Internal Surfaces of Pipelines"

Draft #1: Prepared and Submitted by Task Group; Edited and Processed by NACE Headquarters—August 2016

Draft #1b: Distributed to STG 35 and Interested Parties for Letter Ballot—August 2016

Questions?

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