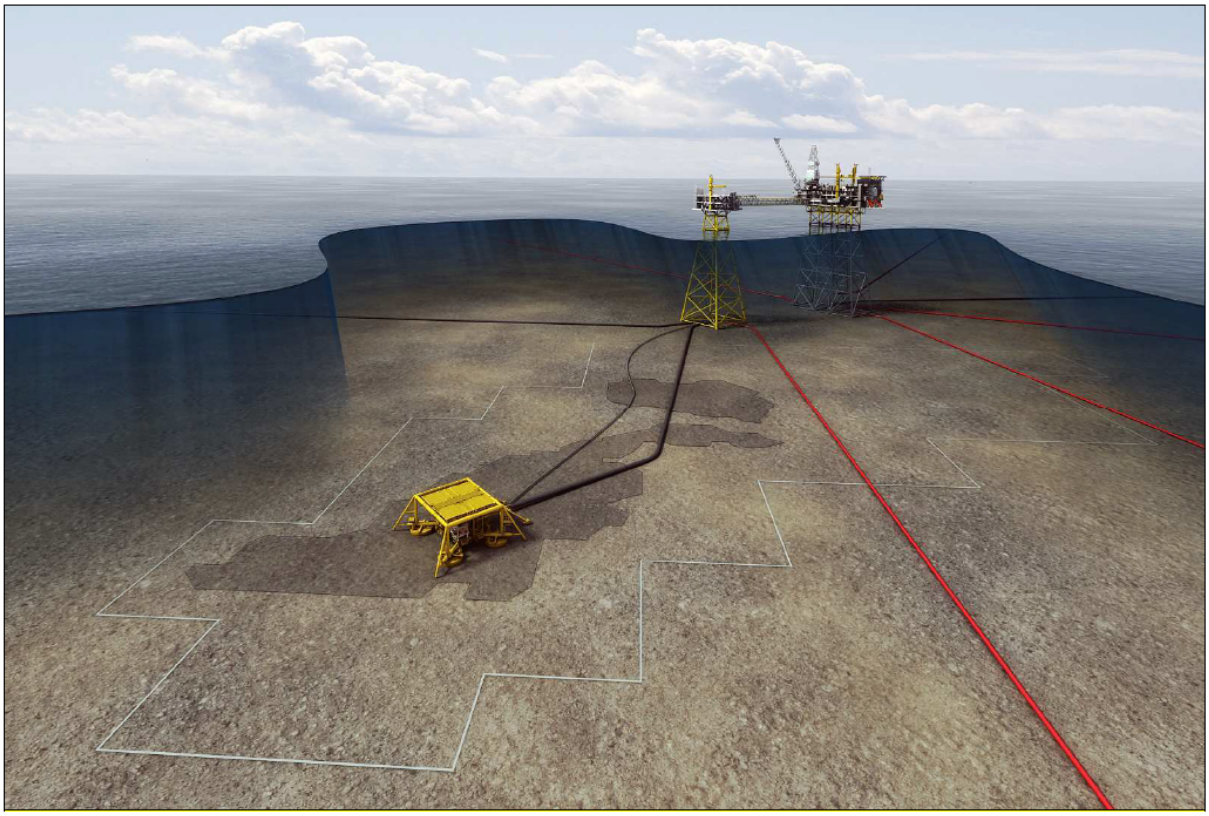
HSE evaluation of using MEG as Hydrate Inhibitor for Vale operations



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1 Background

According to the Activity Regulation §64, the operator shall carry out comprehensive evaluations of the chemicals' potential for environmental harm, based on the chemicals' innate properties, quantities, time and location of discharge, as well as other factors of significance. The assessments shall be carried out before new chemicals are used.

The following documents are referenced:

- Activity Regulation §§62-66, **PSA**
- Oversendelse av tillatelse til produksjon og drift på Heimdal (PL036), 04.March. 2019, **Miljødirektoratet**
- Tillatelse etter Forurensningsloven for produksjon og drift på Heimdal, 04.March. 2019, **Miljødirektoratet**
- Søknad om oppdatering av utslippstillatelse for Heimdal, 18.February 2019, **Equinor**
- Oversendelse av tillatelse til undervannsaktivitet på Valefeltet (PL 036), 29.10.2014, **Miljødirektoratet**
- Tillatelse etter forurensningsloven for undervannsaktivitet på Vale, 29.10.2014, **Miljødirektoratet**
- Søknad om tillatelse til virksomhet etter forurensningsloven ved drift av Vale feltet i Utvinningstillatelse PL 036, 25.06.2014, **Spirit Energy**

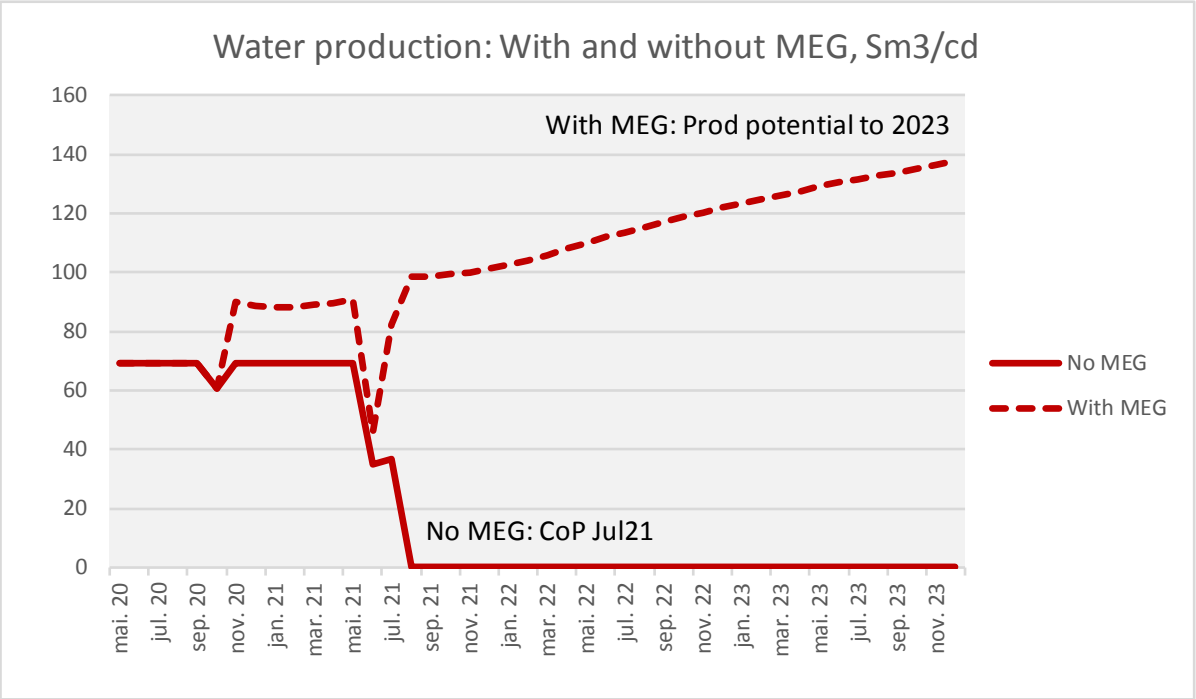
It is identified a need to control formation of hydrates in the production flow at Vale using a dedicated hydrate inhibitor. The hydrate formation is caused by an increasing water cut in the production flow creating environment for hydrate formation. This has previously been controlled by use of pH-stabilised MEG. Due to breakthrough of formation water the pH stabilized MEG is no longer feasible as hydrate inhibitor as severe scaling will occur at Heimdal topside when mixing the two fluids. It is found that a water content in the pipeline > 9 m3 is creating a risk for hydrate plug formation. This can partly be controlled by production flow (minimum 700 kSm3/d), but as water cut increases it is not possible to control flow to ensure a water content lower than 9 m3.

A study was undertaken during Spring 2020 assessing alternative options for chemical hydrate inhibition at Vale:

1. Polymetric hydrate inhibition using the ChampionX product HYDT16637A
2. Anti-Agglomerant using product HYDT19500SE
3. MEG (Monoethylenglycol)

The first option was screened out as it turned out to be a red chemical and also representing a high risk of fouling the Vale inlet heater. Initial lab study work on the Anti-agglomerant revealed interesting results, but the required technical qualification for use at NCS, Vale and Heimdal did not fit the Vale timeline for a hydrate solution. The MEG-option is hence the preferred option which involves partly re-use of existing equipment at Heimdal. With the limited remaining lifetime for Vale (1.5-3 years) and with no regeneration capacity for Vale, the MEG will have to be discharged to sea.
The water rate is expected to continuously increase throughout the field life. According to reservoir simulations a solution is required during Q4 2020. With no solution in place, the

production flow rate from the field will be reduced and hence a lower recovery from the field. The figure below plots water production profile with and without MEG solution, showing the field life can be extended and hence recoverable resources increased with implementation of a MEG-solution.



2 Environmental evaluation

2.1 Inherent Environmental Properties

MEG/Water 90/10 have an approved HOCNF`s registered in the NEMS Chemicals database. The environmental classification is calculated based on the criteria given in Activity regulation §62 and 63. Monoethylene glycol is PLONOR (Pose Little Or No Risk) listed and hence classified Green according to the Norwegian regulation.

Certificate for Chemicals
Environment Colour Classification

NEMS KPD CENTER

Chemical Product	MONOETHYLENE GLYCOL (MEG)
Regulatory Regime	Norway
ID / Version / Date	6541 / 4 / 2020-04-23
Status	Approved
Supplier	Schlumberger Norge AS, Division: M-I SWACO (DS) (LE ID 89)
Contact Info	+47 51577460 - ihelland@slb.com

Environment Colour Green

Colour Banding	Concentration % (normalized)
Green	100

Colour banding calculation is based on normalized concentrations when percentages are given in ranges instead of fixed values.

Certificate No.: 6541
Certificate expires: 2023-04-23 (3 year update)

PLONOR listed chemicals are considered not to pose any environmental risk to marine environment, based on pre-evaluated inherent ecotoxicological properties.

2.2 Environmental risk

Since no ecotox data is available in the HOCNF it is not possible to quantify the potential effects in the environment, other than concluding that it is highly unlikely that even discharge of large volumes of MEG will represent any acute effects or long term effects in the marine environment. MEG is water soluble and will dilute immediate in seawater, with low risk of oxygen depletion, acute toxic effects or bioacumulative effects.
The Safety Data Sheet states that MEG is readily biodegradable, highly water soluble (no potential for bioaccumulation) and are very little toxic to marine environment.

2.3 Dose and discharge factor

Based on the current knowledge of the water production for Vale, it is predicted that the rate will increase from present 60 m3/day to 150 m3/day. The 90/10 MEG/Water dosage to prevent hydrate formation is likely to be in the range 17-28% with 28% representing full inihibtion. Previous study work suggests opportunity for safe operations using underdosed MEG. This will be further studied during 2020 and qualified through operational experience. There may be potential challenges related to storage and logistics for high MEG-rates – hence a 75% uptime is assumed. The annual numbers for use and discharge, is shown in the table below.

Product	SG	Dosage (m3/day)	Total est. annual use (m3) (75% uptime)	Discharge Factor (%)	Total est. annual Discharge (m3)	Total est. annual Discharge (ton)
MEG/Water (90/10)	1,101	15-40	4106-10950	100	4106-10950	4520-12056
MEG	1,113	13-36	3559-9855	100	3559-9855	3960-10968
Water	1	1.5-4.0	410-1095	100	410-1095	410-1095

The expected annual discharge is expected to not exceed 10 000 m3/yr based on current Vale production performance and expectations on required MEG-dosage.

Timing of Vale Cease of Production (CoP) is currently being discussed and a decision to postpone CoP from October 2021 to June 2022 is expected in the near future. If a decision is made on postponed CoP to June 2022, there is an option to be called off June 2021 to postpone CoP further to June 2023.

The current Heimdal discharge permit do not specify amount of green chemicals allowed to use and discharge, only that "necessary" amounts are allowed. However, if a significant increase in use and discharge is planned, the Environmental Agency must be consulted. A clip from the permit:

3.5 Krav til stoff i grønn kategori (stoff på PLONOR-listen)
Tillatelsen omfatter bruk og utslipp av stoff i grønn kategori i det omfang som er nødvendig for gjennomføring av de planlagte aktivitetene. Tillatelsen er ikke knyttet til bestemte typer og mengder kjemikalier. Anslag over planlagt forbruk og utslipp av stoff i grønn kategori er gitt i operatørens søknad. Ved betydelig økning i forhold til anslått mengde stoff i grønn kategori, skal behov for ny søknad avklares med Miljødirektoratet.

Based on the above, its quite evident that introduction of MEG/Water as hydrate inhibitor for Vale will represent a significant increase in use and discharge of green chemical, and hence a consultation with the Environmental Agency is required.

3 Working environment and safety

The product is documented with a safety data sheet prepared according to the CLP requirements. It is classified, and subject for registration in the Product register. The actual use on the Heimdal platform are subject for health risk assessments, and this is covered by Equinor and the systems/operational procedures on the platform.

3.1 Inherent health classification

The classification given in SDS are given in the table below:

Product	Health Classification	Health phrases	Precautionary phrases	Health Category	Safety Category
MEG/Water (90/10)		**H302** Harmful if swallowed.	**P270** Do not eat, drink or smoke when using this product. P264 Wash contaminated skin thoroughly after handling. **P301+312** IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell. **P330** Rinse mouth. **P501** Dispose of contents/container in accordance with local regulations.	2	1

3.2 Working environment evaluation

The product is classified as harmful if swallowed, Health category 2, which is acceptable and rated green according to NORSOK S002. Main precautionary measure is to facilitate safe working environment, with reduced manual handling through technical measures. If manual handling is required, correct PPE must be used according to the rules at Heimdal

4 Conclusion

The operational challenges with potential formation of hydrates in the production system, must be resolved as soon as possible. Currently the best option for this, both environmentally and technically, is to use MEG/Water (90/10). The main challenge with this option is that it requires significant dosage and total volumes to be effective.

Environmentally the chemistry is PLONOR listed and will not pose any environmental risk being discharged, even such amounts will rapidly be diluted in seawater and not cause any negative effects on short or long term.

However, such large increase in use and discharge of green chemical must be consulted with the Environmental Agency, to consider if it requires an extended permit.

5 Referanser

SDS for MEG, **Schlumberger**
HOCNF for MEG, **Schlumberger**
Activity Regulation §§62-66, **PSA**
Oversendelse av tillatelse til produksjon og drift på Heimdal (PL036), 04.March. 2019, **Miljødirektoratet**
Tillatelse etter Forurensningsloven for produksjon og drift på Heimdal, 04.March. 2019, **Miljødirektoratet**
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