

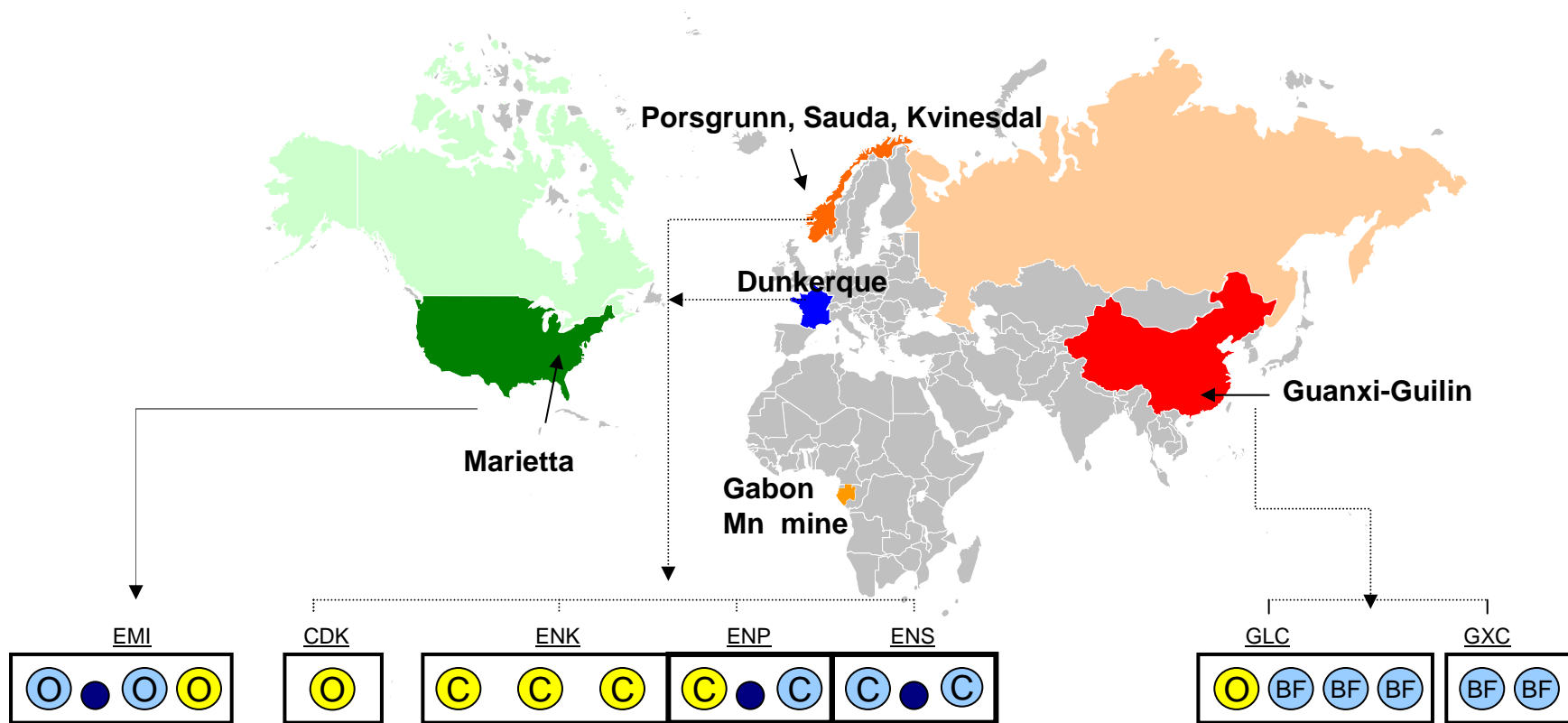


MANGANESE

WATER LEAKS DETECTION SITUATION IN ERAMET COMILOG MANGANESE

- ❑ ECM: Mn alloys operation and Safety policy
- ❑ Water leaks: existing situation in ECM
- ❑ EN works on water leaks detection systems
- ❑ Water leaks detection: ECM action plan
- ❑ Appendix: study on water leaks evaporation
- ❑ References

ECM: Mn alloys sites – general description



- Mn mine output: 3,5 mt
- Alloys output: 0,8 mt
- Two new projects: in Gabon (EMM - SiMn), in China (GLC – EAF)
- Staff: 7000 people



Eramet : Safety policy - TARGET ZERO ACCIDENT

❑ INDIVIDUAL INVOLVEMENT

- Everyone is responsible for his / her workstation, for his / her own safety and that of his / her colleagues, and:
 - ⇒ Strictly observes procedures
 - ⇒ Sets an example
 - ⇒ Watches out for any irregularities

❑ CONSTANT COMMITMENT

- Safety is an integral part of our business. It is:
 - ⇒ Factored into the design of our facilities
 - ⇒ Upheld through careful operation and maintenance
 - ⇒ Continuously improved through in-depth analysis of every incident or accident

❑ PRIMORDIAL PREVENTION

- Eramet applies all relevant regulations and defines its own safety procedures.
 - ⇒ Managers run prevention policy on every site
 - ⇒ Safety coordinators support safety and prevention actions



Water leaks: existing situation in ECM

- ❑ ECM has different furnaces and different history
 - BF in China: open circuit. No big issue, visual surveillance of collection trays for water courses: steam and irregular flow rate are the key-points for water leaks detection.
 - BF in Boulogne (stopped in 2003): on the big BF (commissioned in 2001), very precise water flow rate measurements in the inlet and outlet of tuyers circuits was installed. Worked well in a very aggressive environment!
 - Open furnace in Dunkerque (Elkem design) is equipped with close loop system and safety tank allowing a precise follow-up of even small water leaks.
 - Open furnace at Marietta, visual surveillance of furnace and collection trays for water courses is the lone way – detection is sometimes difficult !
 - In these two last plants, there is a restriction for access around the furnaces.



Water leaks: existing situation in ECM

- In Norway, furnaces are sealed (3 plants – 7 furnaces between 30 and 40 MW)
 - Obviously this situation is even more critical and requires a close follow-up.
 - Furnaces are mainly equipped with open circuit.
 - Different detection systems are used:
 - ⇒ Gas analysis (H₂) – good correlation with large leaks
 - ⇒ Water flow-rate and temperature follow-up
 - ⇒ Cameras on water return (steam detection) at Porsgrunn
 - There is a restriction for access around the furnaces and some en water leak occurs. Some general routines are applied when a water leak is detected
 - In 2005 when a serious explosion occurred at Sauda due to water leaks (no people injured), EN decided to launch a work-team with R&D support.
 - ⇒ The objective was to have first a benchmark study on different existing systems for water leaks detection
 - ⇒ Then to perform industrial tests with new technologies and some calculations on water leaks impact (see appendix)



EN works on water leaks detection systems

Helium detection

Principle (Varian 2009):

- Small amounts of He is added to water
- Highly sensitive He detection device mounted in off gas channel

Positive:

- Not influenced by seasonal changes

Negative:

- Not tried for Mn-SAF
- Will it work?
 - Highly sensitive to off gas production

Able to detect inside/outside furnace, but not location of leak

EN works on water leaks detection systems

Water monitoring (Tveit et al. 2008)

- ❑ After eruption at Elkem Tamshavn plant in 2006 water course monitoring is being installed at all Elkem plants
- ❑ Used on both closed and open systems
- ❑ Closed system = less leaks, better cooling

Principle:

- ❑ Difference: water in – water out

Positive:

- ❑ Detects what water course is leaking
- ❑ Detects relative small leaks

Negative:

- ❑ Requires high quality water
- ❑ Costly



Picture from Tveit et al. 2008



EN works on water leaks detection systems

Other available detection methods

Expansion tank monitoring

Principle:

Measure amount of water in system to keep constant amount of water

Positive:

- Accurate measurement of feed to expansion tank
- Can detect small leaks
- Inexpensive

Negative

- Not possible to detect where the leak is

Good backup system!

H₂ off gas measurement

Principle:

Measure H₂ level in off gas channel

Positive:

- System used today

Negative:

- Not able to detect all leaks
- Influenced by seasonal changes (snow, ice...)

Not totally satisfactory

H₂O off gas measurement

Principle:

Measure H₂O level in off gas channel

Positive:

- Able to detect leaks

Negative:

- Affected by seasonal changes
- Can systems be tuned to take into account seasonal changes?
- Size of leaks detected?

Can detect leaks inside the furnace



Water leakage detection: *action plan at EN (closed furnaces)*

Requirements from Authorities: *“relevant and necessary criteria”*

- ❑ Identification of where is the leak in the system
- ❑ Identify how much water is leaking from the system
- ❑ Water leaks alarms must be managed specifically (high risk)
- ❑ Routines surrounding water leaks must be reviewed

Eramet Norway action plan *still under discussion*

- ❑ Closed system and water cleaning system *
- ❑ Monitoring for each water course (know which course is leaking)*
- ❑ He-detection or H₂O off gas measurement (is the leak inside the furnace?)
- ❑ Global leak follow-up: expansion tank monitoring*

* *Planned to be installed during coming furnace upgrades*



Water leakage detection: *action plan in other plants (open furnaces)*

Open furnaces: action plan *still under discussion*

- Closed system and water cleaning system *
- Monitoring for each water course (know which course is leaking)*
- Global leak follow-up: expansion tank monitoring*
- Access to water courses should be removed from exposed areas when not done

** Planned to be installed during coming furnace upgrades*



Water leakage detection: common action plan

Other aspects towards safety

- ❑ Improve electrodes and cover components to avoid leaks !
 - Scientific approach on cooling efficiency and quality of equipments
 - Predictive maintenance on components is a critical point

- ❑ Management of water courses outside critical area

- ❑ Reduce personnel access to critical area
 - No access to HC FeMn furnace tops today during operation

- ❑ Review procedures when leaks are detected (in progress)
 - Personnel should not be exposed to furnace when a leak is detected and the furnace must be turned off



Water leaks detection: water evaporation issue

Appendix: Assumptions for “size of critical water leak” estimate for FeMn (from study on Si metal)

- Charge is cooled to minimum 200C (too low temperature?)
- Leak spreads on a 1 m³ area (too large area?)
- Charge down to -3 m evaporates water
- 2 measured T-profiles from closed HC FeMn furnaces used for calculation
- Heat capacity from Braunitite (Tang 2009) and Graphite (Aylward and Findlay, 1998)

Comment: Assumptions may be too optimistic, giving a too large capacity.

Result: Charge can evaporate 0.3-0.5 m³ before accumulation starts (a large leak may be 6 m³/h → 5 min to reach critical accumulation (0.5 m³))

Worst case scenario:

Water accumulates above a bridge that collapses → eruption

Other aspect:

Furnace should (probably) not be stopped while a leak is going on ??

Based on calculations by Tveit et al. 2008



Water leaks detection: references

References

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Water leaks detection: Eramet presentation

Thanks for your attention !