GOLD FIELDS

AMRE SAFETY SEMINAR: MAKING OUR PEOPLE WORK SAFER

Ice Plants: Lower temperatures improve environmental conditions and thus safety

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The complete Gold company

Background

Background

- Ice was harvested and stored in China before the end of the 1st Millennium.
- Iced liquors & frozen juices popular in France 17th century.
- Ice commercially shipped from New York in 1799.
- 35 Commercial ice plants in USA in 1879, more than 200 a decade later and 2000 in 1909.
- 14 to 15 million tons of ice were consumed in 1907 already.
- Brewing was the 1st activity to use mechanical refrigeration extensively since the 1840's. (Sulfur dioxide and methyl chloride caused people to die. CFC's in 1928.)

- Gold Mining industry – Late 20th century.

Environmental Background

Environmental Background

- Reject temperature of 28,5°C in Gold Fields
- Deep mine studies indicate that the thermal limit for unimpaired cognitive performance range between 28°C and 30°C (Wet-bulb)
- Ability to concentrate and spatial perception decrease when wet-bulb start to exceed 28°C (Maintain speed of performance at lower accuracy)
- >29°C – individuals work faster, but less accurate
- Specific bearing on operators using joystick / lever controls

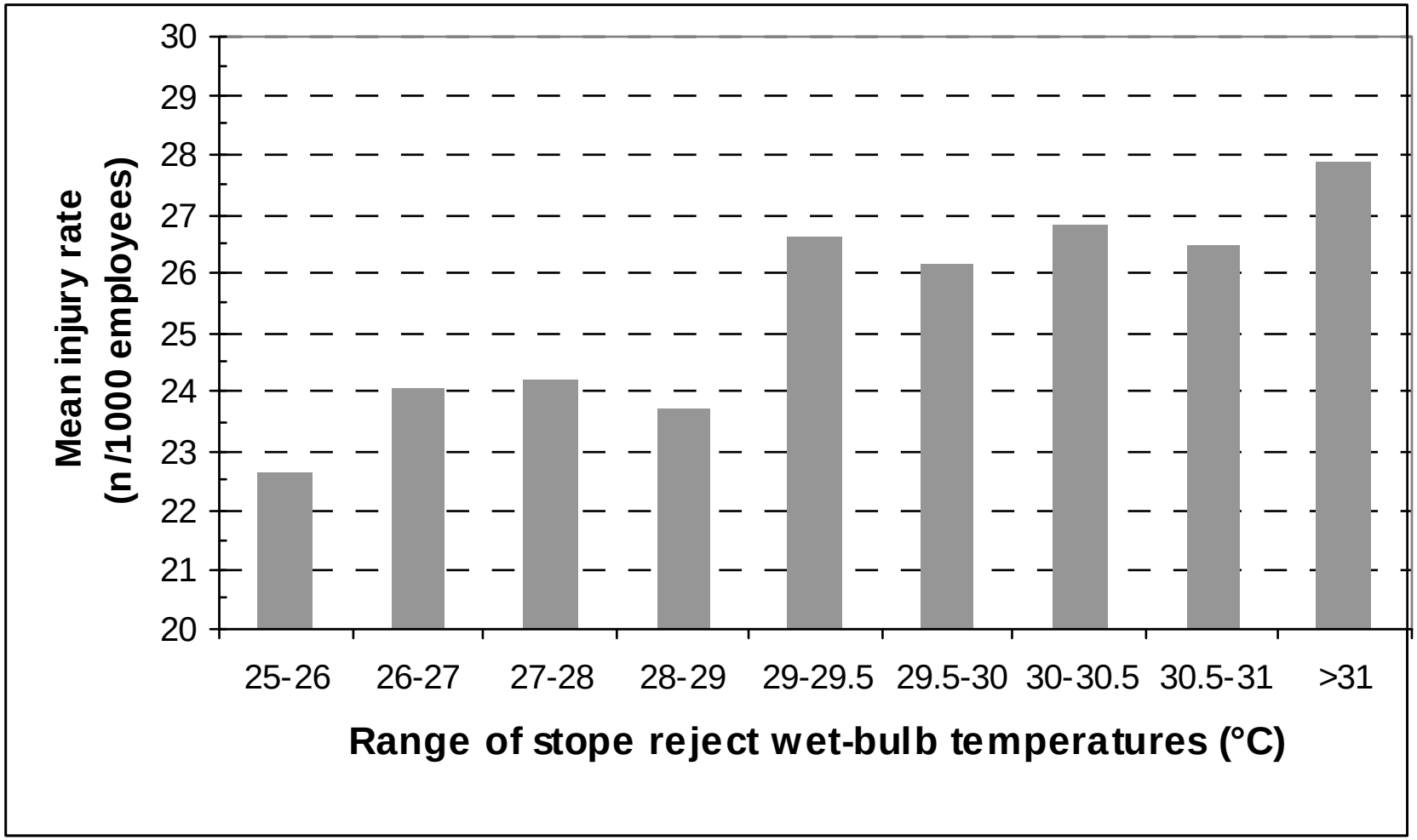
Performance vs Wet-bulb

Reductions in performance at various wet-bulb temperatures

Wet-bulb temperature (°C)	Physical performance decrement (relative to performance at 25,0°C)
25,0	0% (assumed)
27,0	3,8%
29,0	14,0%
31,0	50,5%
33,0	70,2%

Gold Fields

Mean Reportable Injury Rate



Why Ice?

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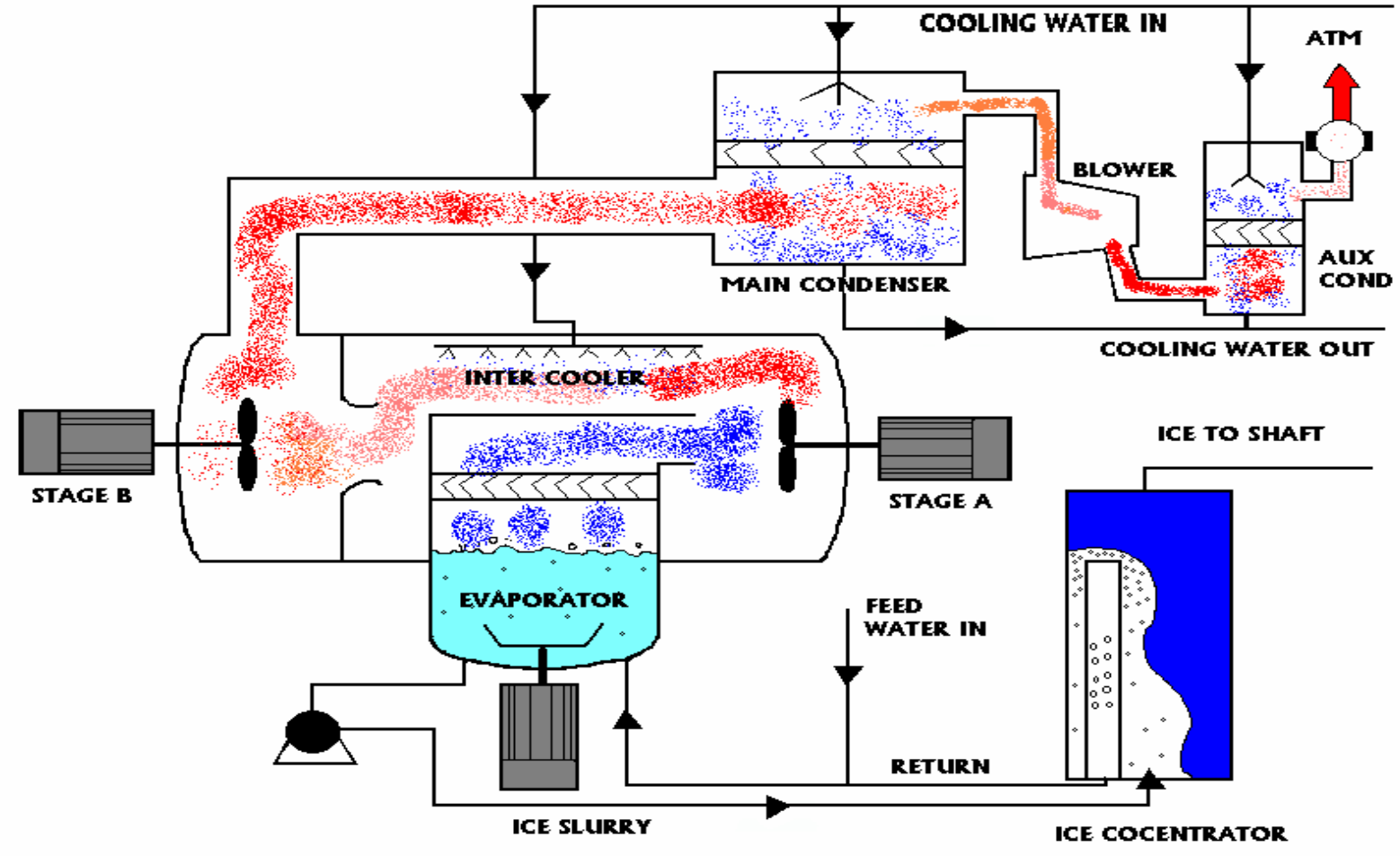
- With the ever increasing demand for more and more gold at a cheaper cost, mined deeper, a paradigm shift is required.
- The deeper areas needs more cooling, meaning more services and more cost.
- Water is a big NO in mining and is not only expensive to get rid of, but it is also expensive to supply.
- Ventilation and cooling is one of the biggest constraints for mining at depth. (Deep Mine)
- 3500m quoted at Deep Mine.
- The new economical depth for ice underground is getting shallower and is approximately 1500m according to expert opinion.
- Ice plants are becoming cheaper and pumping is becoming more expensive.
- Pumping reduced up to a factor of five.

Vacuum Ice Process
vs
Ammonia Ice making

Vacuum Ice Plant Operation

- The process uses the phenomenon of the triple point of water, where vapour, liquid and ice coexist. Inside the VIM (Vacuum Ice Machine), water is subjected to triple point conditions in a tank under vacuum. The flashing forces part of the water to evaporate while the remaining liquid freezes. Within this process the latent heat of crystallization causes evaporation.
- For every kg of vapour flashed off, about 7,5kg of ice crystals are formed.
- Produces slurry ranging between 17% to 75% ice mass fraction (IMF).

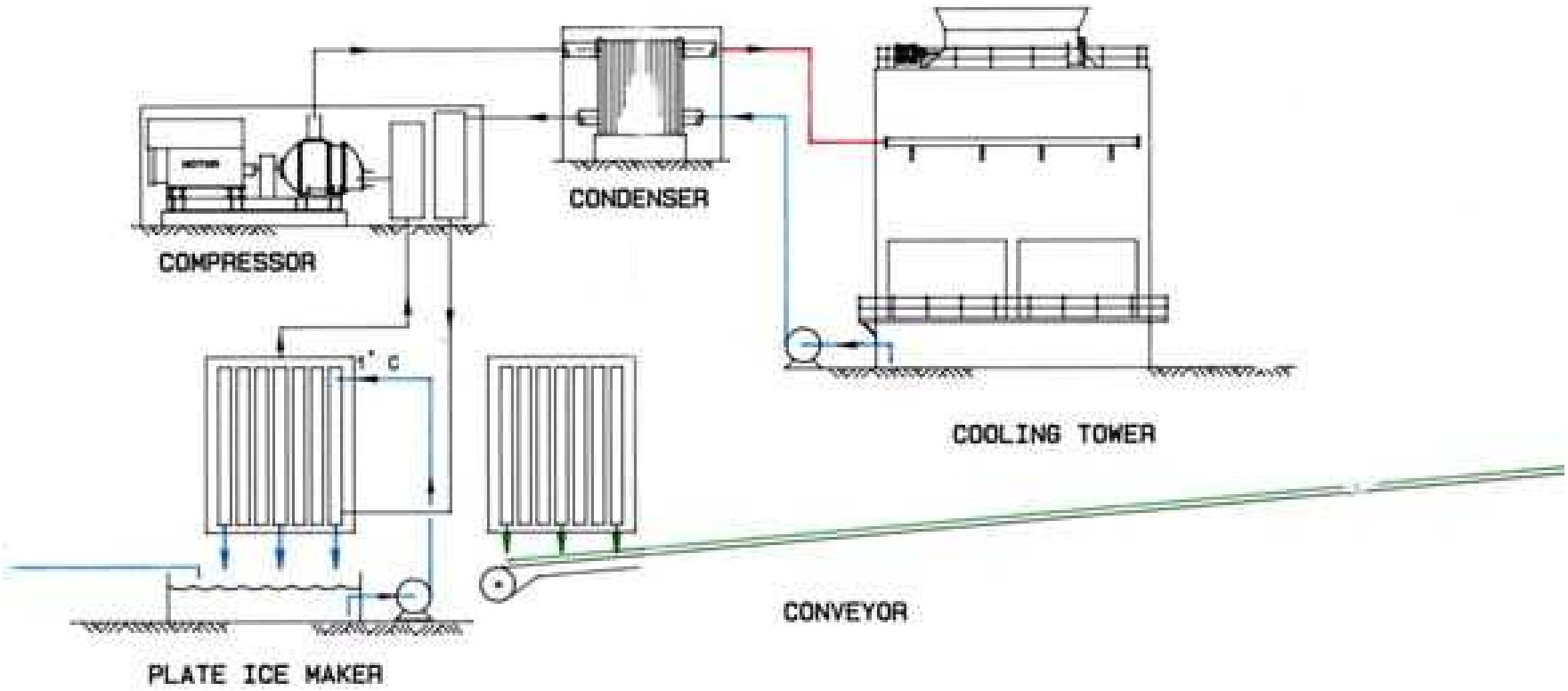
Vacuum Ice Process



Ammonia Ice Plant Operation

- Ammonia is used to cool down.
- Ammonia is used to chill water on plates to form ice.
- Gassed off ammonia is used to heat the plates to dislodge the ice.
- Ice falls on screw feeder and is conveyed to the shaft.

ICE MAKING PLANT



Gold Fields

Comparison

	Vacuum	Ammonia
Cost	R7000/kW	R5200/kW
Ice mass fraction	70%	90%
Ice : Water ratio	3.8 x less pumping	5 x less pumping
Technology	Still developing (Compressors surging due to high ambient temperature)	Proven (ERPM)
Efficiency	High 242 tons / MW	11MW=9MW nominal 312 tons / MW @ 70% IMF
Safety	Water not harmful	Ammonia harmful to people
Environment	Salt / Brine mess up environment	Ammonia not harmful to nature
Risk	Salt damage steelwork	Ammonia could be managed safely

Ammonia Modular Design

Ammonia Modular Design

- Infrastructure on surface – Plant to shaft.
- Civils.
- Sound attenuation.
- 11MW (9MW nominal) – Two compressors.
- Two sets of ice plates.
- Interchangeable with compressors.
- 1 module = 23 kg/s (1988 tons per day)
- R60m for 1 module and infrastructure to shaft.
- Modules could then be added at R41m per module.
- EIA needs to be conducted. (R340 000)
- Risk assessment needs to be done.
- Prevailing wind direction to be considered.
- Safety circuit part of the modular system.
- Redundancy???

Ammonia Safety (People)

- Very deep inhalation of ammonia gas could lead to death.
- Contact with ammonia gas causes:
  - Eye and nose irritation.
  - Upper respiratory tract problems.
  - Possible corrosive injuries if liquefied gas comes into contact with the skin.
- Immediate medical treatment must be given to people whom suffer from asthma, respiratory tract problems, severe inhalation exposure, eye or skin burns and people who have ingested ammonia.
- What to do:
  - Lead people out of contaminated zone.
  - Give oxygen if available.
  - Wash with plain or saline water for more than 5 minutes if there had been skin contact.
  - Always wear gloves and safety glasses.

Ammonia Safety (System)

- Spray showers over plate heat exchangers, compressor seals and pressure relief valves.
- Building ventilation to be done with louvers and extraction fans. Water spray scrubbing installed in the draught area of the fans.
- Trenches and sump in building floor.
- Ammonia detection sensors in building.
- Fire extinguishers at each door.
- Fire reel and hose.
- Breathing apparatus at each door.

Summary

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- There are many ways to reduce the cost of mining, i.e. water management.
- 3CPF etc need to be looked at in conjunction with ice plants to get the optimal efficiency and cost effectiveness.
- There is no doubt that ice should have been introduced to gold mining when the brewing hit it off with ice.
- Why should fishing be the leader in this market?

Acknowledgements

- I would like to thank Gold Fields and Kloof Management for the opportunity to present this presentation.

- Special thank you to the following people who worked hard in putting all the background work together:
  - Stefan van Heerden
  - Dave Farlam
  - Doug Foley
  - Mike de Koker

Questions

Have you made that paradigm shift?