

Reinhold Environmental Ltd.



2006 APC Round Table
& Expo Presentation

July 16-18, 2006, Columbus, OH

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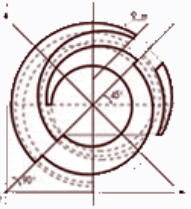
July 18, 2006

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Investigation of a New ESP Design After an Oil Fired Boiler

Steve Francis

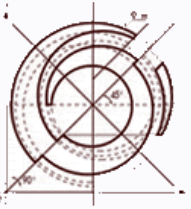
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Content



- Introduction
- Karlshamn Power Plant, Sunrod Boiler, fuel
- New APC equipment at KKAB: WFGD + ESP
- Principles of the ERDEC design ESP (+Flowpac)
- Design of the new ESP at KKAB
- Dust measurements
- Results of performance testing
- Conclusions

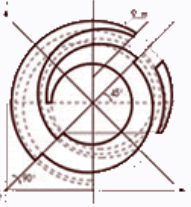


ESP's

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- Over the many years of use, hundreds of design improvements have made ESP's highly efficient, very reliable and affordable
- New developments continue to increase the performance results and lower the cost
 - AVC's
 - High Frequency Power Supplies (SIR's)
 - Supervisory Control Systems
 - **New Collecting & Discharge Electrodes**
 - Advancements in Rapping Systems

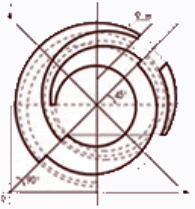




Background



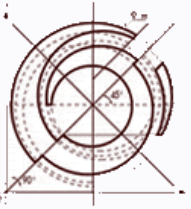
- Dr. Hara – inventor of the design
- Filtration Japan - now ERDEC
- Some tests performed by ALSTOM PPL in Windsor after DoE campaign around 1994
- Target - 20% decrease in ESP volume (large scale plants)
- ERDEC has 56 references of various kinds
- World Wide Licensee agreement between ALSTOM and ERDEC



Karlshamn Power Plant (KKAB)

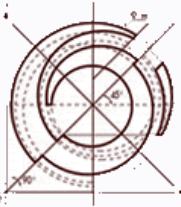
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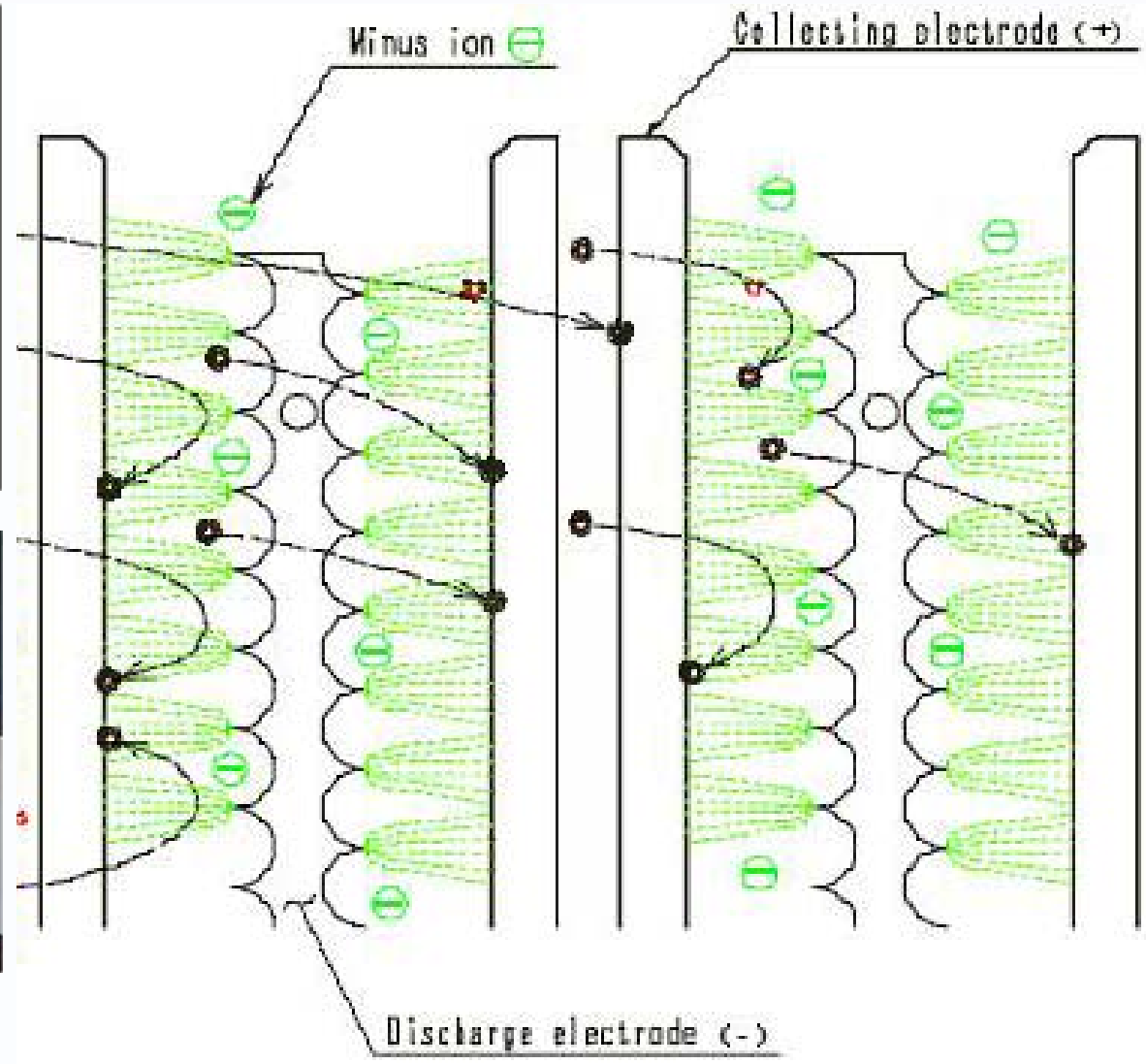
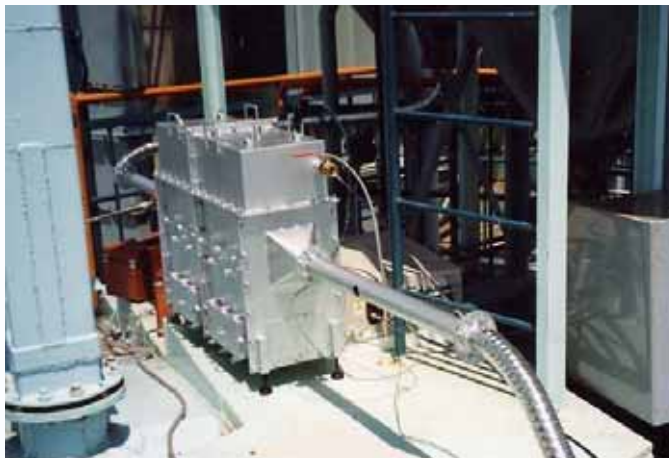
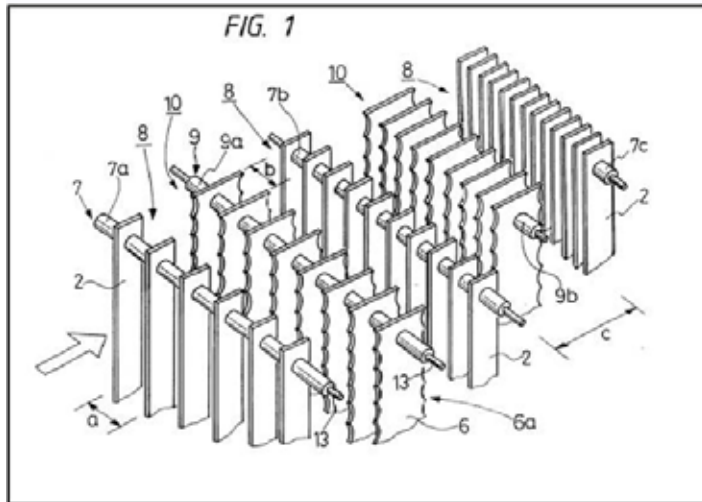


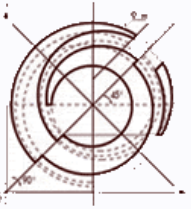
Fuel Oils

- Low sulphur heavy oil:
Sulphur 0.27%; Ni 8 mg/kg; Va 10 mg/kg
Water 0.1%; HV 42.2 MJ/kg
- High sulphur heavy oil:
Sulphur 2.1%; Ni 34 mg/kg; Va 82 mg/kg
Water 0.2%; HV 40.9 MJ/kg
- Water emulsion (high sulphur oil + water)
Sulphur 1.4%; Ni 23 mg/kg; Va 57 mg/kg
Water 31.9%; HV 27.2 MJ/kg



Working Principle of the New ESP

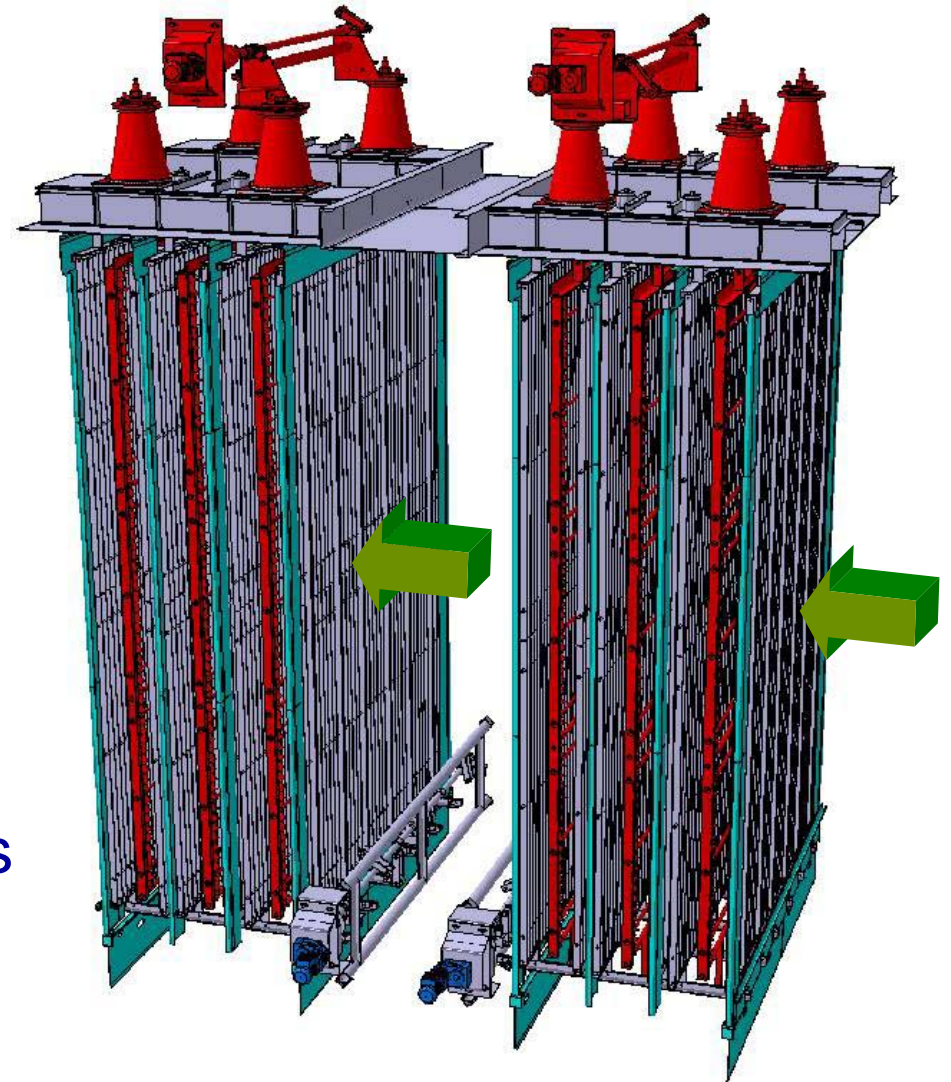


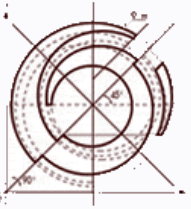


Design – KKAB ESP

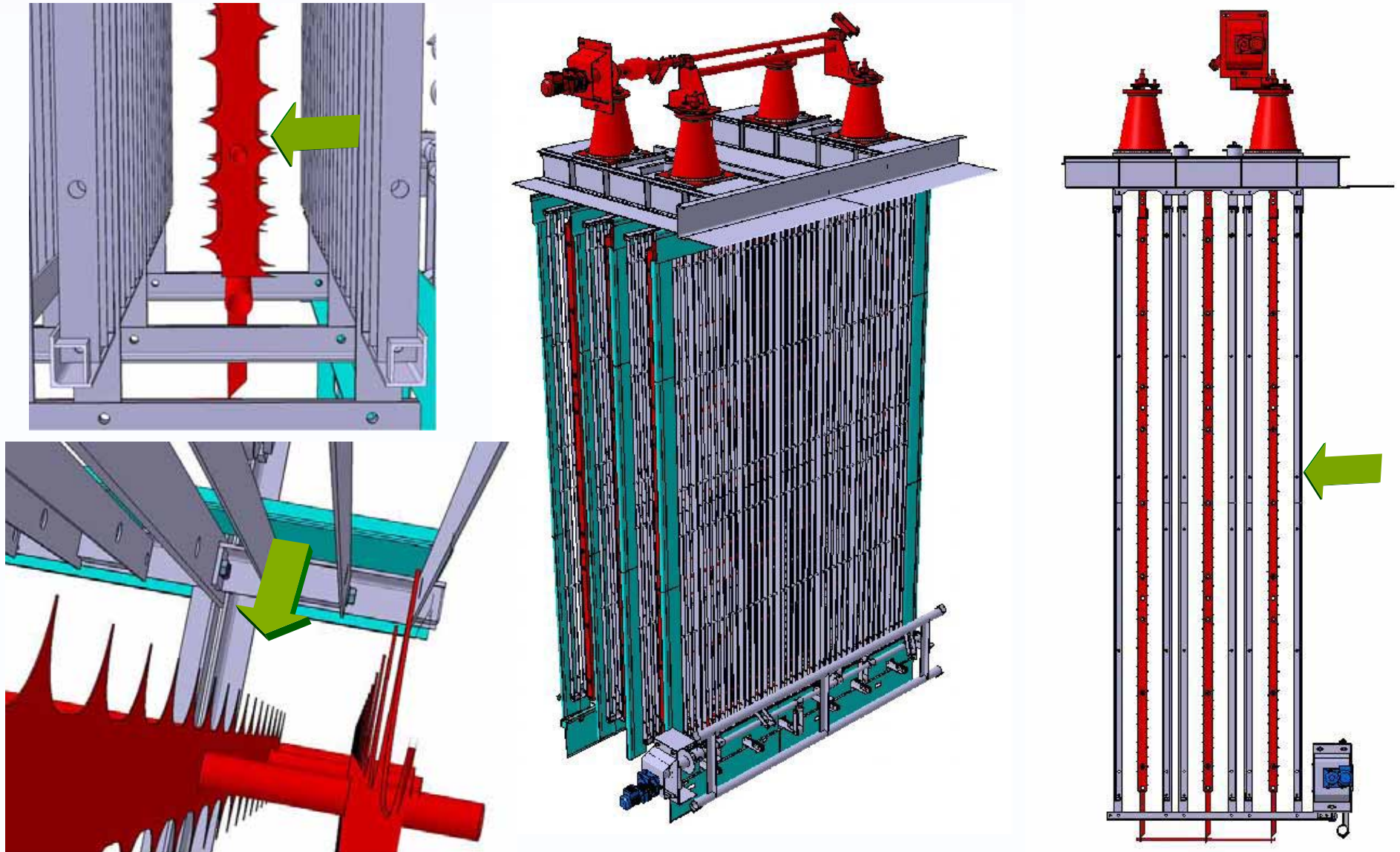
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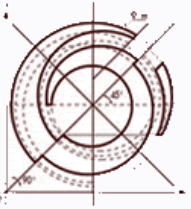
- Two field ESP of ERDEC design
- Built inside conventional casing
- Compact design
- Three modules / field
- CE bottom rapping
- DE top rapping
- High frequency power converters





Details of the ESP Internals



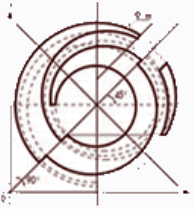


Installation Views



Electrodes (during acc. measurements)

External view (inlet of ESP)



Measurements **low sulphur oil**

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Inlet loading ~ 250 mg/Nm³ (@ 5%O₂, 280°C)

Low collection efficiency obtained ~ $\eta = 60\%$

Huge opacity peaks observed during rapping

Rapping switched off during measurements gave $\eta = 99\%$

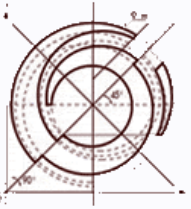
After ~ 3h without rapping performance start to deteriorate

Modification of rapping bolting and hammers done

New rapping times (less frequent)

Efficiency now about 90% including rapping

Slurry of Flowpac OK



Measurements high sulphur oil

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Very low inlet loading ~ 15 mg/Nm³

Extremely fine particles – corona suppression

Plane filters clogged due to fine particles; too high ΔP ...

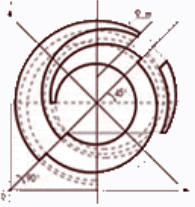
Agglomerating properties of the dust is good

Electrodes kept clean via more frequent rapping

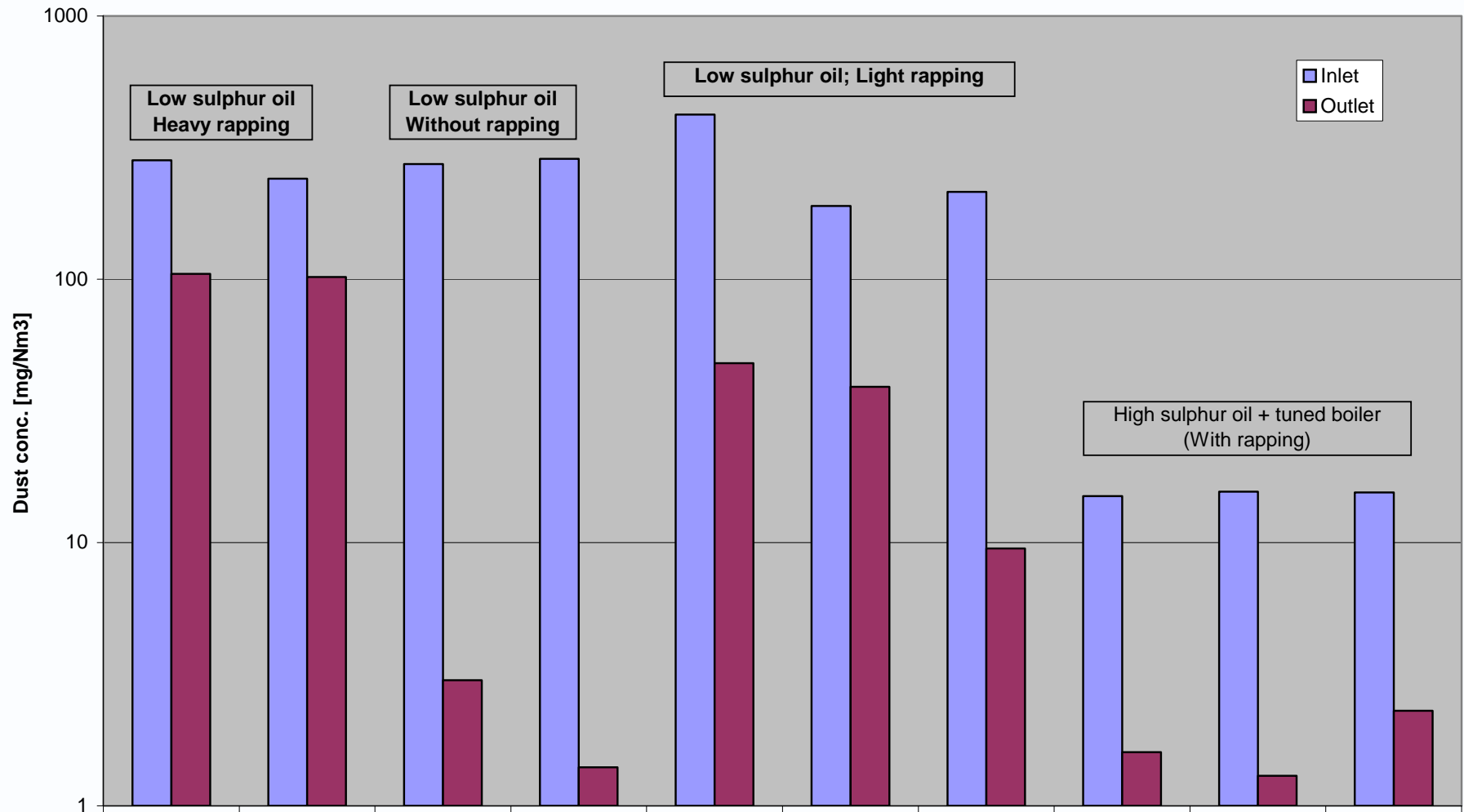
Collection efficiency >90% (including rapping)

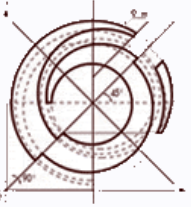
Outlet particulate emission 1 – 2 mg/Nm³

("Emulsion fuel" gives very similar results)



Summary of Performance





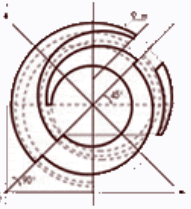
Conclusions

- Depending on type of oil very different conditions for the ESP were observed
- With some modifications performance expectations were met
- Concept needs additional development work to be installed in larger ESP's and for different applications
- The new ESP design is useable for both new and retrofit opportunities
- Additional R&D work in progress...

The background features a blue and white striped pattern with a large red curved shape on the left side. The Alstom logo is centered in the white area.

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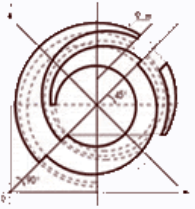
Erection of New APC Equipment

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WFGD of Flowpac type installed to be able to fire high sulphur oil.

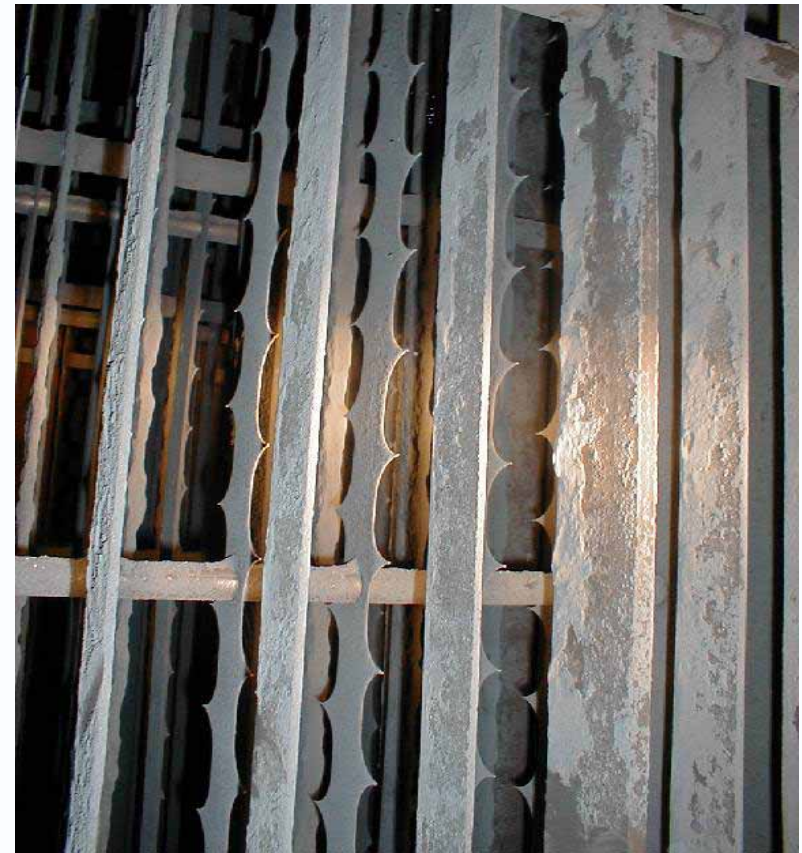
ESP needed to produce gypsum of commercial grade. The ESP is based on ERDEC design.



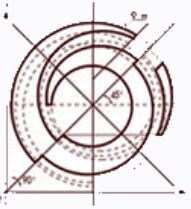
KKAB ESP Operation



Dust Layer Low S Firing



Dust Layer High S Firing



Sunrod auxiliary boiler at KKAB

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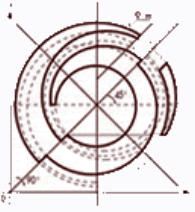


Supplies heat to the buildings and the oil storage + Steam for help processes and start-up.

Mostly continuous operation.

One rotary burner; Can be run on various oil types.
Max. load is about $15 \text{ MW}_{\text{th}}$.

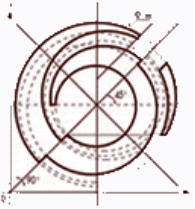
Previously fired only low sulphur light oil, with direct discharge to atmosphere.



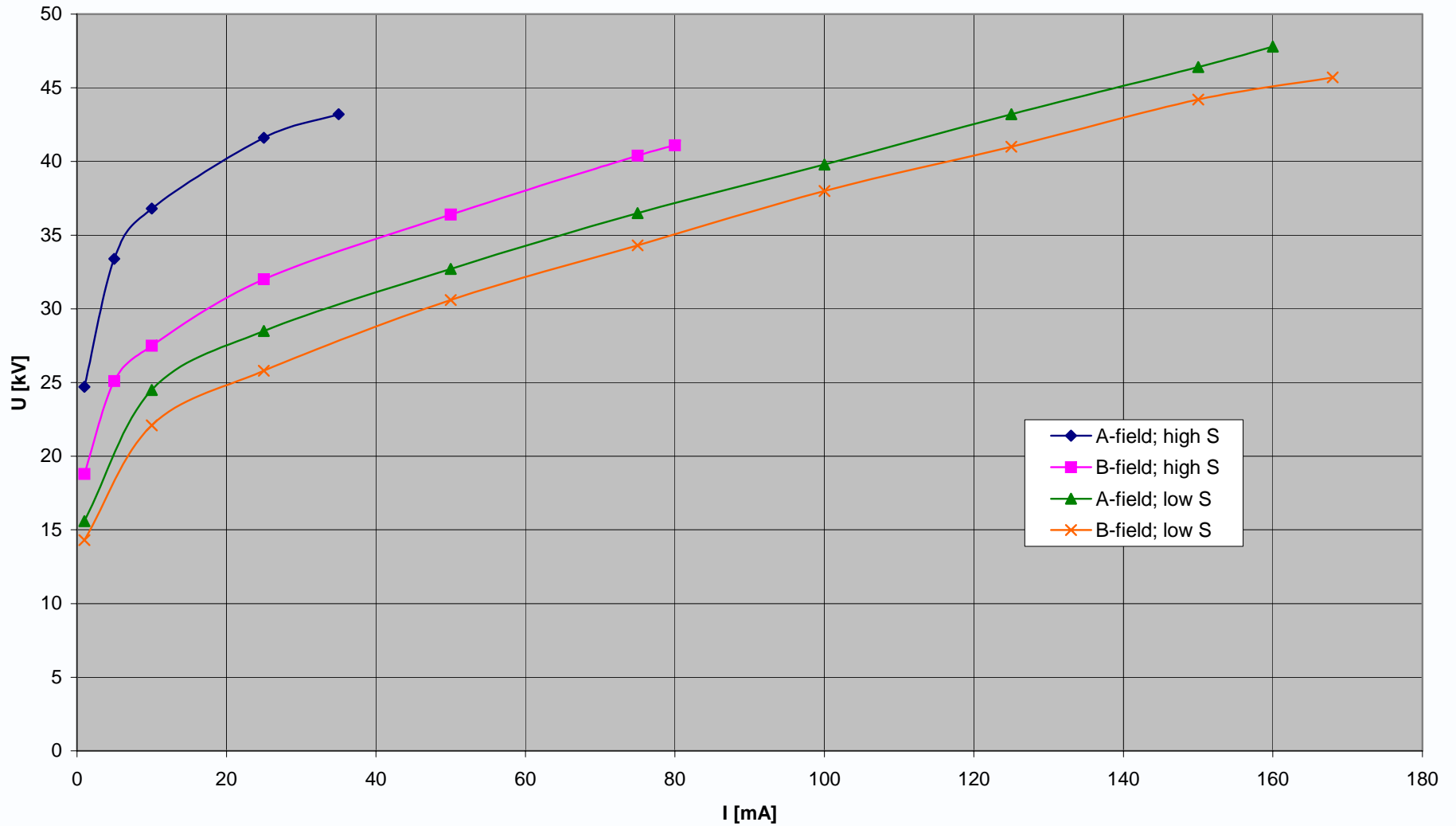
Dust sampling measurements

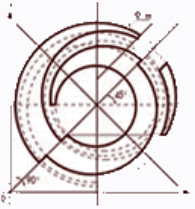
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Typical I-V curves (low S, high S)





Dust sampling filters



Plane filters; high sulphur oil



Thimbles; low sulphur oil