CHEMISTRY THAT MATTERS™

FURNACES EXCESS OXYGEN OPTIMIZATION

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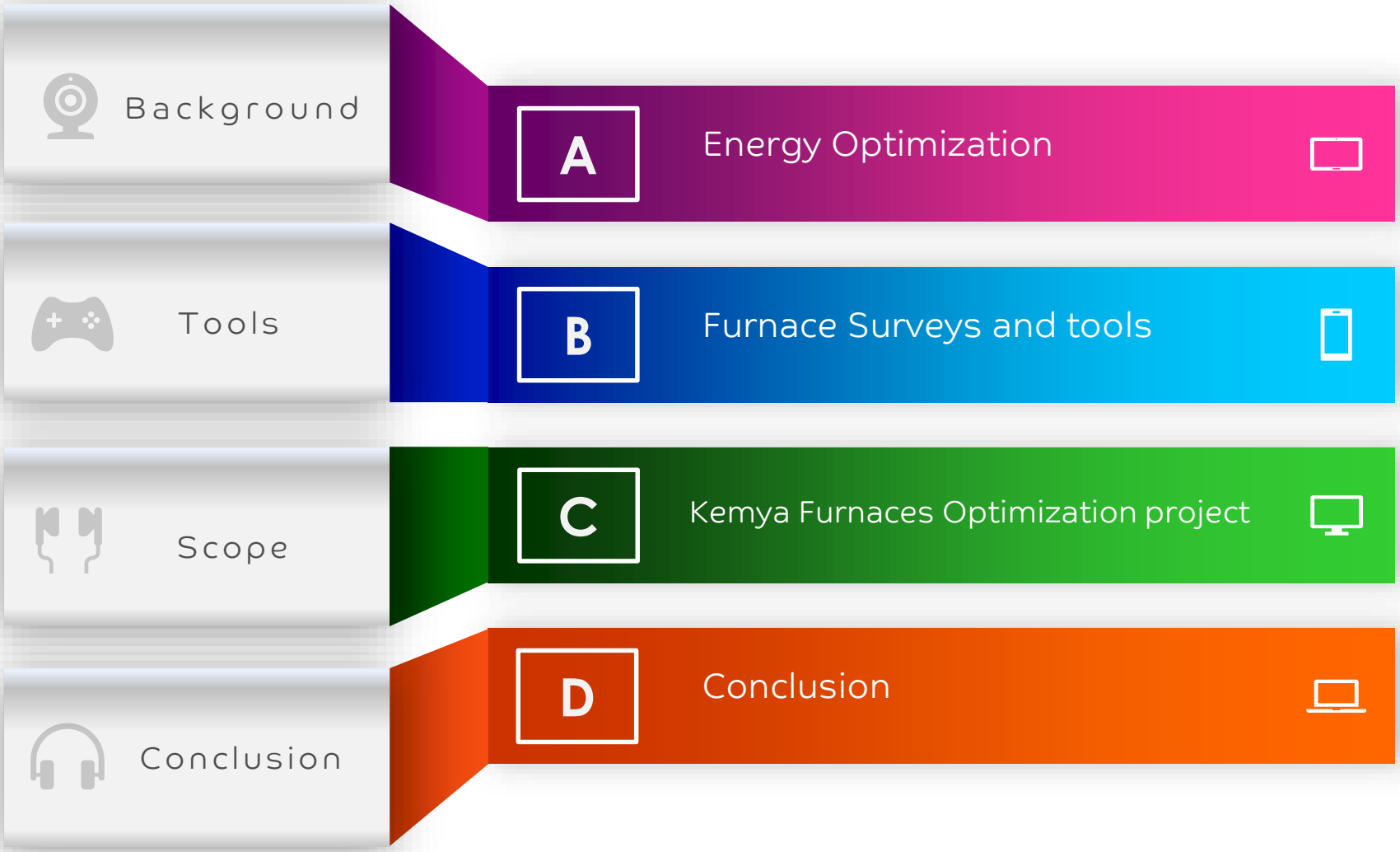
OUTLINE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ENERGY OPTIMIZATION

- Steam cracking is the most energy consuming process in the chemical industry
- Around 80% of total plant energy consumption is in the pyrolysis furnaces.
- Significant potential energy savings by monitoring and improving performance of the furnaces.

ENERGY OPTIMIZATION - FURNACES

- The furnaces optimization objectives are :
  - ✓ Maximize heat delivery of the process-side feed while minimizing fuel consumption.
  - ✓ Maximize heat delivery with varying fuel quality.
  - ✓ Minimize stack temperature and emissions (heat, CO, NO_x).
  - ✓ Maximize safety integrity levels.

- A first opportunity to improve the efficiency of heat generation is to control the air-to-fuel ratio in furnaces.

- Air should be controlled in excess oxygen to ensure complete combustion.

› Optimizing furnace operation with reducing excess air in the furnaces is easy way to improve energy savings and close SEEC target gap

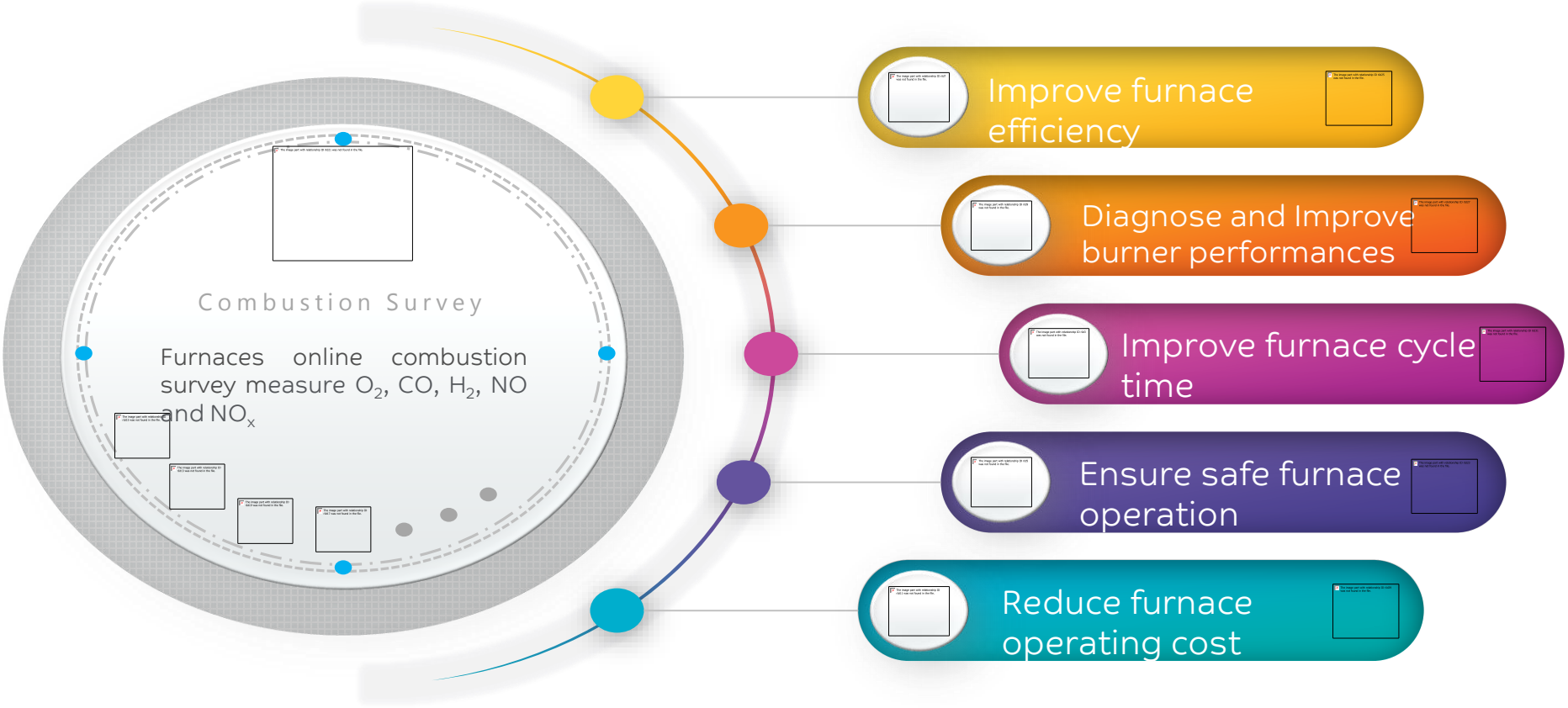
FURNACE SURVEY

Conducted Furnace Assessment Surveys at Kemya for firebox side evaluation and troubleshooting

- Combustion Analysis
- Tube Metal Temperatures
- Draft measurements

› Combustion survey highlighted opportunity of energy saving

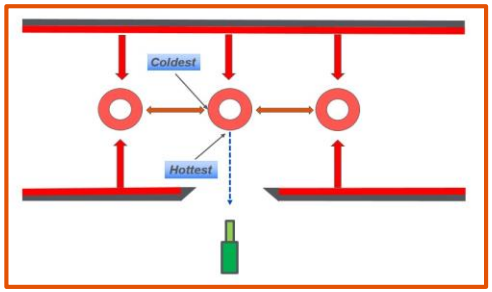
INTRODUCTION TO COMBUSTION ANALYZER



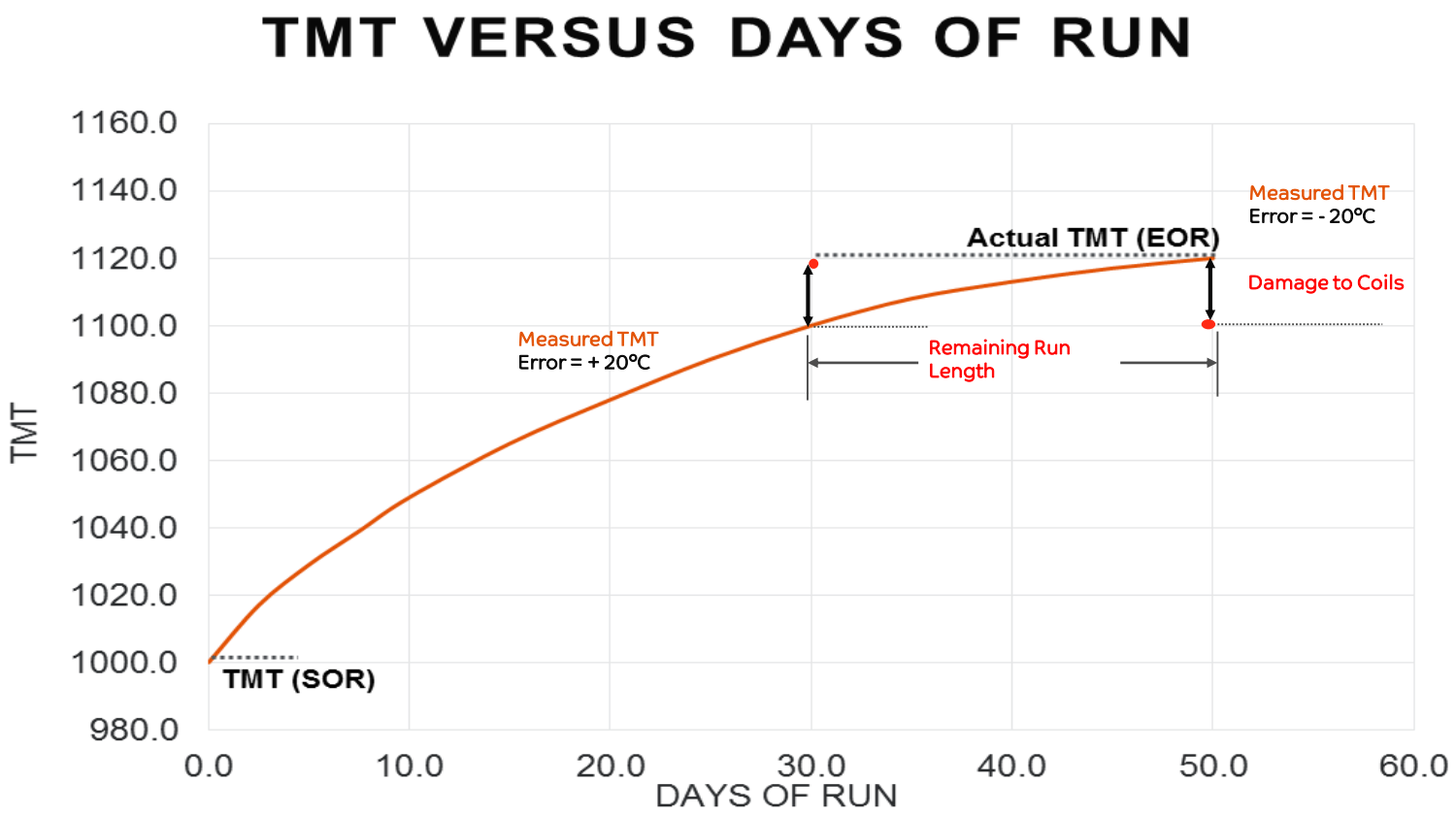
STATE OF THE ART TMT MEASUREMENTS

•Pyrometer Survey – Measure radiant tube metal temperature

- Instrumentation – accuracy of calibration
- Nature of the body, e.g. emissivity
- The surrounding of the furnace tubes
- Procedures to take pyrometer survey (e.g. angle of the pyrometer)
- Determine furnace end of run
- Protect furnace equipment and ensure furnace operation
- Prolong service time of the radiant coils



IMPACT OF GOOD TMT MEASUREMENTS

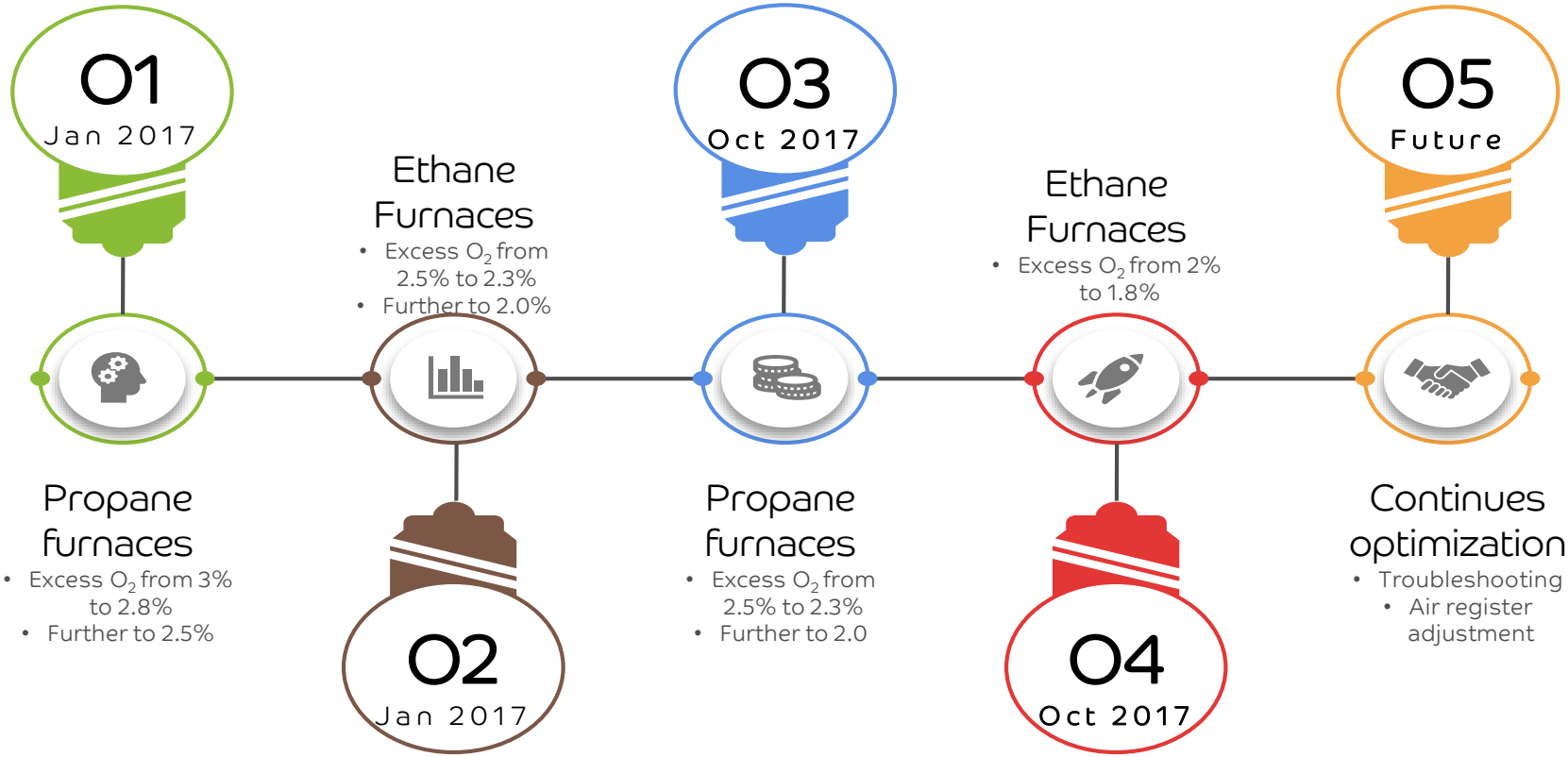


Accurate TMT measurements can be used to guide and improve operations

KEMYA OLEFINS – FURNACE COMBUSTION OPTIMIZATION

- Kemya Olefins plant – has 7 furnaces online and 1 HSSB
- Plant operating with 3% excess O_2 with propane feed and 2.5% excess O_2 with ethane feed
- Reduction of fuel gas consumption was the target to improve toward SEEC target (quick win)
- Furnace combustion survey viewed as opportunity to execute optimization with confirmation of excess O_2 levels inside firebox to ensure complete combustion and safe operation

KOP – COMBUSTION OPTIMIZATION TIMELINE



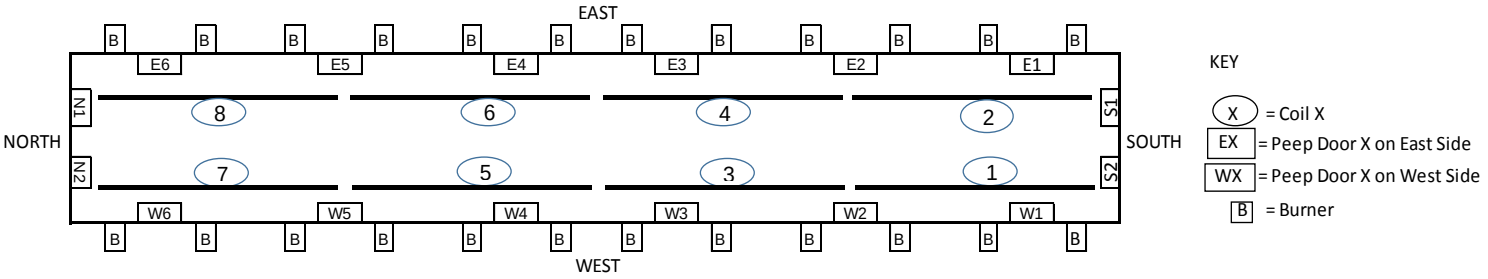
COMBUSTION OPTIMIZATION PRE-CONDITIONING

- Burners properly adjusted to maintain uniform fire box temperature – optimal furnace efficiency
- Draft control and setting – significant impact on energy
  - ➢ Positive draft - Hot gases and flames leaving furnace
    - ✓ Safety issue
    - ✓ Heat damages structure
  - ➢ Too negative a draft - Air infiltration inside furnace
    - ✓ Reduces furnace efficiency
    - ✓ Safety issue – afterburning in convection
  - ➢ Draft and excess oxygen
    - ✓ Burner air damper adjustment
    - ✓ Adjust draft and excess oxygen by adjusting ID fan speed or stack damper position iteratively

KOP – COMBUSTION OPTIMIZATION WORK PLAN

- Furnace survey for baseline evaluation performed in Jan 2017

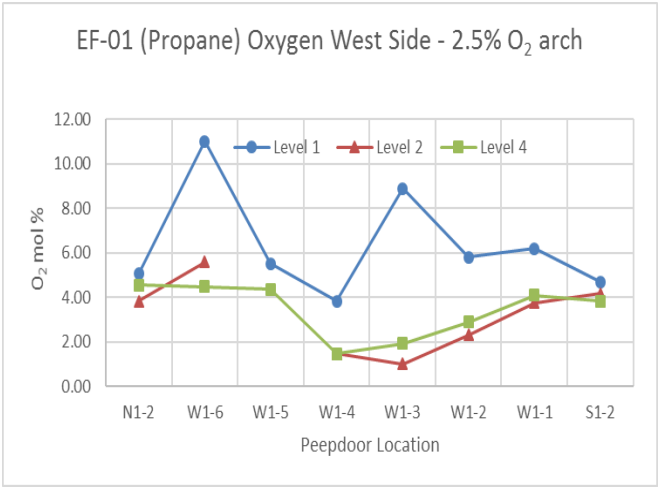
- Pyrometer and combustion survey:
  - ✓ Combustion survey: Flue gas analysis – O_2, CO, H_2, NO, NOx at all levels (4 levels + arch)
  - ✓ Draft measurements at arch
  - ✓ TMT measurements for all coils

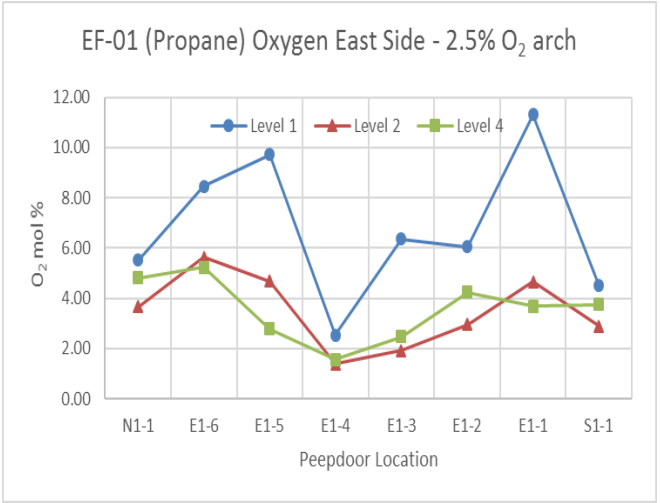


COMBUSTION OPTIMIZATION BASELINE SURVEY - OCT 2017

- Evaluation of furnaces at baseline performed
  - ✓ 2.5% excess O_2 for C3 feed furnace

- Combustion profile not uniform – related to air registers settings for hearth burners
  - ✓ 4% excess O_2 - dry basis at arch measured with Testo analyzer
  - ✓ Arch draft measured at -11.4 mm water matching DCS reading





COMBUSTION OPTIMIZATION RESULTS - OCT 2017

- Evaluation of furnaces at new conditions:
  - ✓ Furnace combustion performance was monitored with process parameters maintained constant
  - ✓ Target excess oxygen was provided as set point in DCS and damper position changes to achieve target with corresponding change in draft observed at arch

	Excess O2%	FPH outlet Temp,°C	Ave CIT, °C	SHP, tph	stack tem, °C	FG, Kg/h	Duty, MW	draft, mmH2O	damper position, %
Delta, %	20.2%	4.6%	1.3%	6.0%	4.5%	4.6%	6.0%	34.8%	20.0%

ENERGY SAVINGS FROM OPTIMIZATION

- Significant fuel gas savings realized from optimization of excess oxygen:
  - ✓Lummus propane furnaces from 3.0% to 2.0%
  - ✓Lummus ethane furnaces from 2.5% to 2.0%

- Reduction of steam production expected from optimization of excess air requires makeup of steam production from Utility boilers

- The overall net energy saving is more than **53,000 GJ/yr**

OVERALL SAVINGS FROM FURNACE OPTIMIZATION

- Reduction of ethane furnace to 1.8% excess oxygen showed potential for similar savings but oxygen levels in the middle of the furnace at the higher elevations were approaching zero

- Plan is to continue optimization and adjustment of air registers for ethane furnace at 1.8% excess oxygen and potentially reduce further on both propane and ethane furnaces

- Frequent survey can be planned whenever needed for further optimize or troubleshooting

CONCLUSION

- Operating at lower excess oxygen has to be combined with combustion measurements to assess the safe operability window
- With the use of combustion survey the team was able to realize benefits of energy saving in the furnace by operating at optimized excess oxygen level
- Steam production shortfall and subsequent makeup by lower efficiency boilers reduces net savings and dilutes the benefit from fuel savings in furnaces
- Saving from this exercise is significant as no CAPEX is required and can provide quick win compared to other projects

Furnace survey is a useful tool available, service provided with portable analyzer, it can help also for furnaces troubleshooting

QUESTIONS

ANY QUESTIONS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THAT MATTERS
THANK YOU