


UMATAC Industrial Processes

Fushun ATP Project Update & Value Added Processing

Colorado School of Mines 35th Oil Shale Symposium (Salt Lake City)

October 5, 2015

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A company of ThyssenKrupp Industrial Solutions

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Rev: 0

FMG Operation Update

Plant Operation Improvements:

→ 115 day run length achieved.

→ 80% overall plant availability (95% of design target).

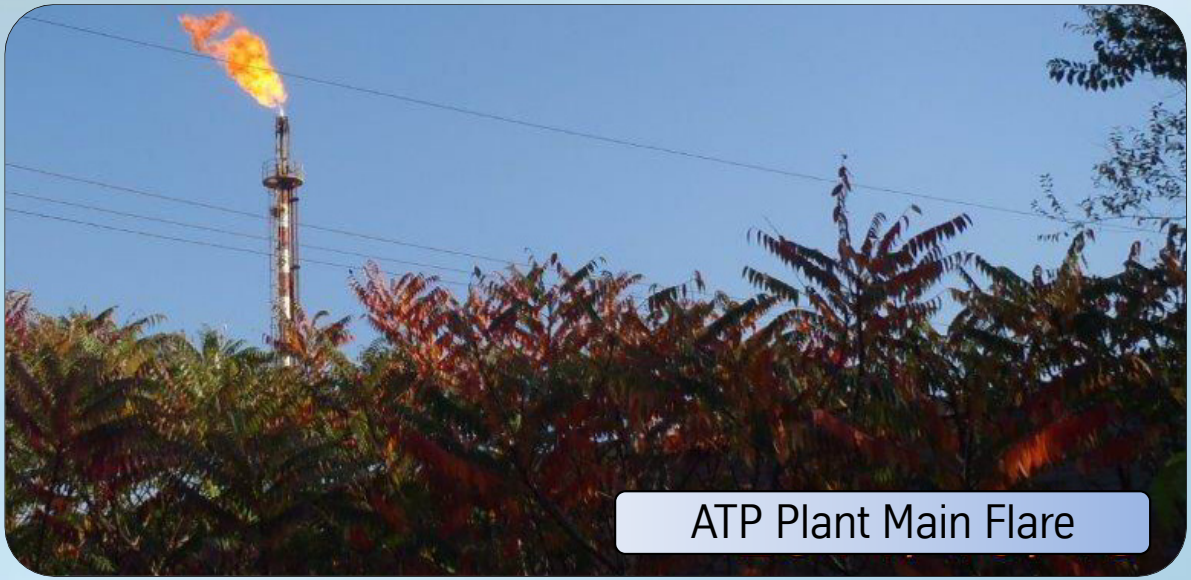
→ 95% ATP Processor availability.

Challenges:

- **Equipment reliability.**
- **Bottlenecks.**
  → 87% of design feed rate.
- **Low ore grade from mine.**
  → Low grade = low oil production and low coke yield (primary fuel source).

Opportunities:

- **Used tire pyrolysis.**
  → Low CAPEX for tire shredding. High OPEX for tire collection.
  → No modifications to ATP.
  → Plant oil production +20%.



ATP Plant Main Flare

Oil Production

FMG ATP Plant - 2014/15 Operations Update

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Start Date	Run Length	Feed Rate	Notes
Jul. 2014	40 days	160-180 t/h	FMG sets goal of improving operability.
Oct. 2014	30 days	160-180 t/h	Operating error shuts down oil recovery system.
Dec. 2014	70 days	160-180 t/h	Train derailment disrupts shale supply, ATP burner modified to burn fuel gas.
Feb. 2015	50 days	120-160 t/h	Baghouse bag blinding, plant operates through minus 30°C weather.
Apr. 2015	**115 days**	**140-180 t/h**	**Equipment reliability challenges (i.e. 115 days of operation plus ~12 days of short unplanned outages).**
Sep. 2015	**> 100 days**	**180-230 t/h**	**Partial install of high capacity baghouse bags, new flue gas boiler.**

FMG ATP Plant Control Room

FMG ATP Plant - Availability

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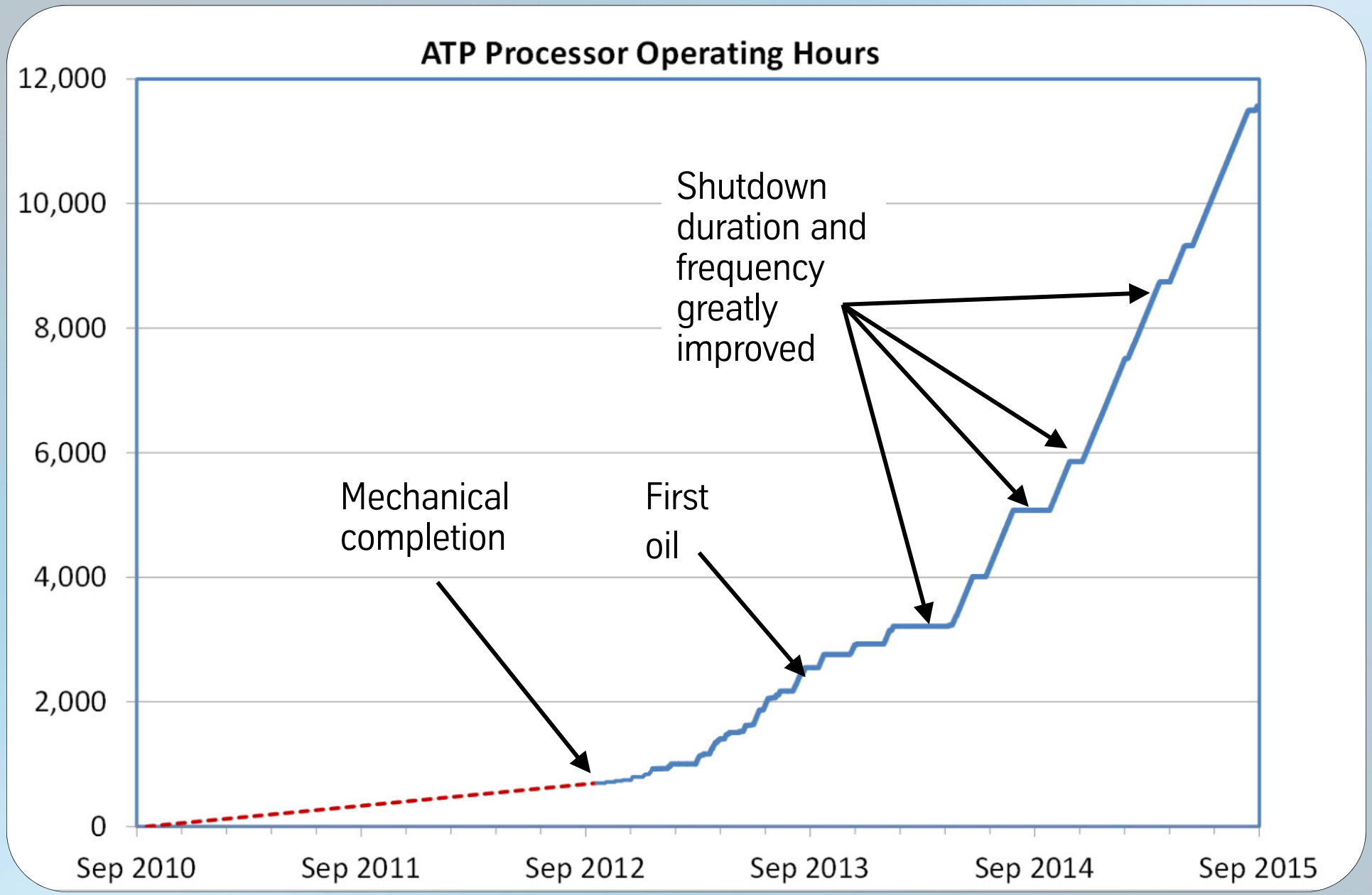

Shutdown target: 10 days, once every 3 months – achieved.

FMG ATP Plant - Flowsheet

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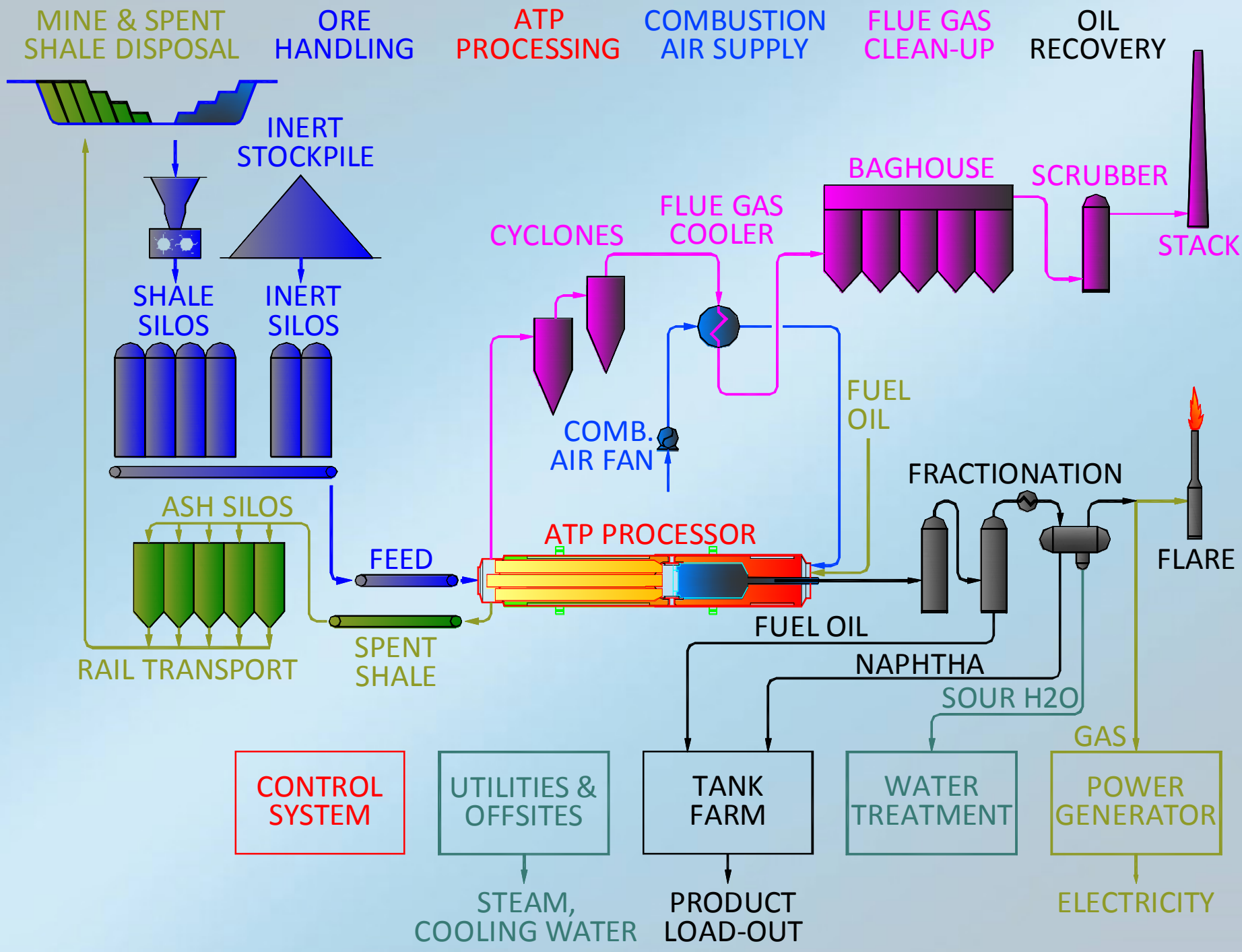

FMG ATP Plant – Bottleneck Modifications

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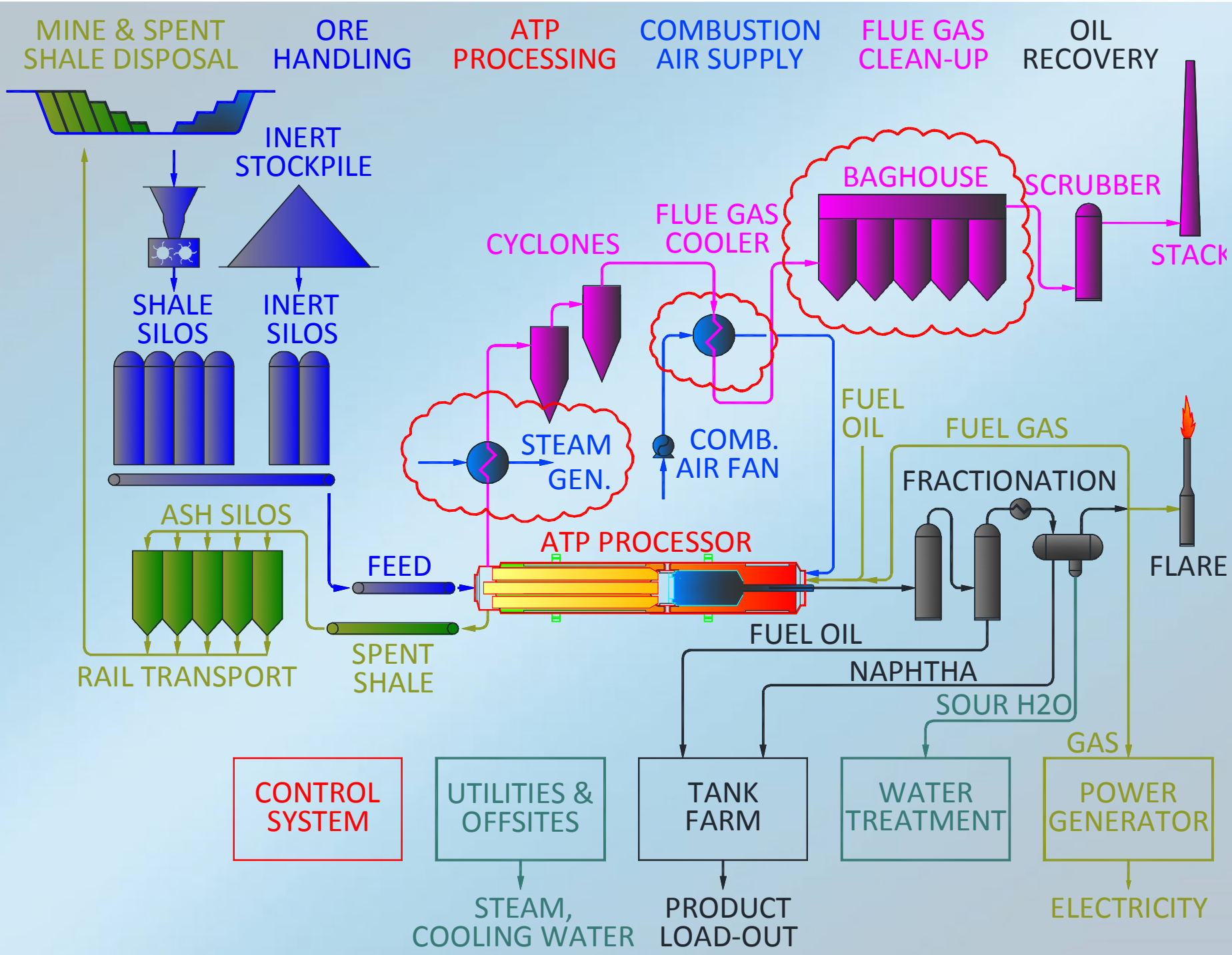


Flue Gas Steam Boiler & Baghouse Bags

Flue Gas Cooler / Air Preheater

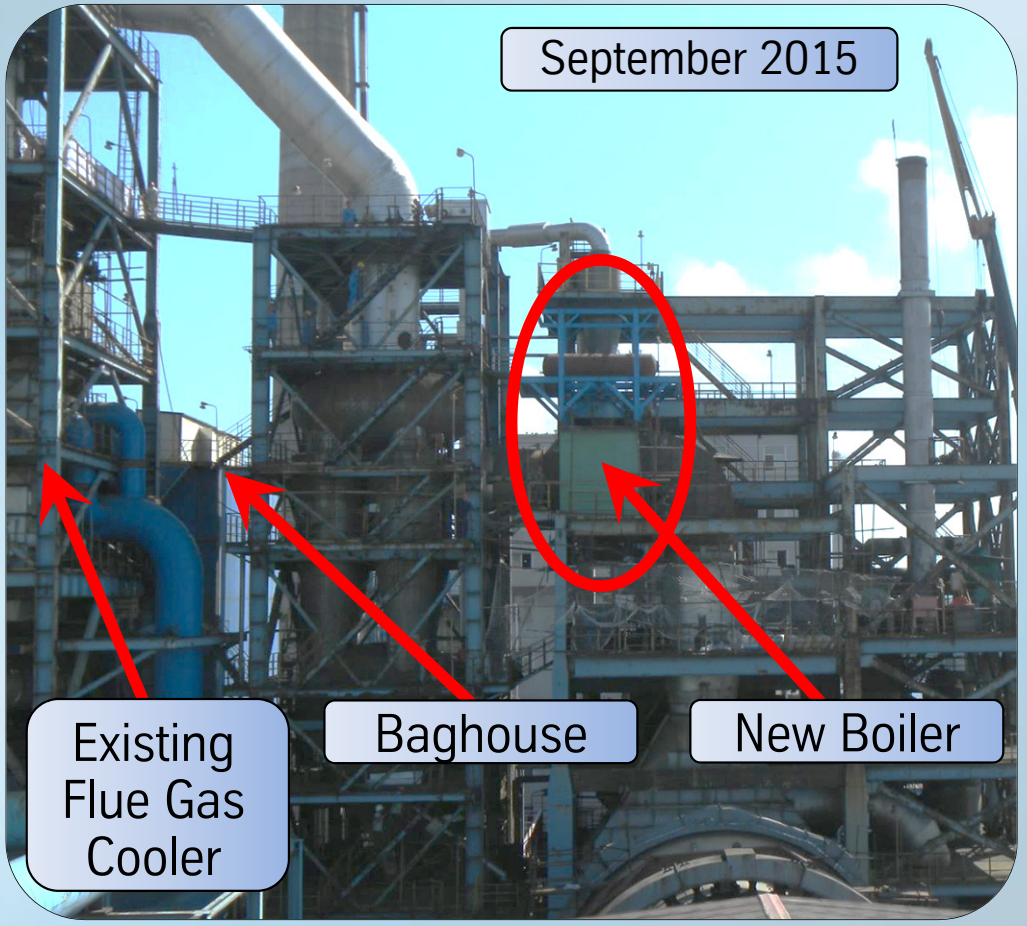
- Fouling issues from 2014 solved, but solution reduced cooler capacity.

Flue Gas Steam Boiler

- New steam boiler installed – increases flue gas system capacity and produces utility steam.

Result

- 1 MPa steam produced and ATP feed rate increased to >200 t/h.
- High capacity baghouse bags to be installed. ATP rate to 100% of design.



Unplanned Downtime Comparison

Stuart Demonstration (2004)

- → Ash system.
- → Duct fouling.
- → Corrosion (2004).
- → ATP support systems (e.g. lube oil cleanliness).

FMG ATP Plant (2014/15)

Avoidable downtime:

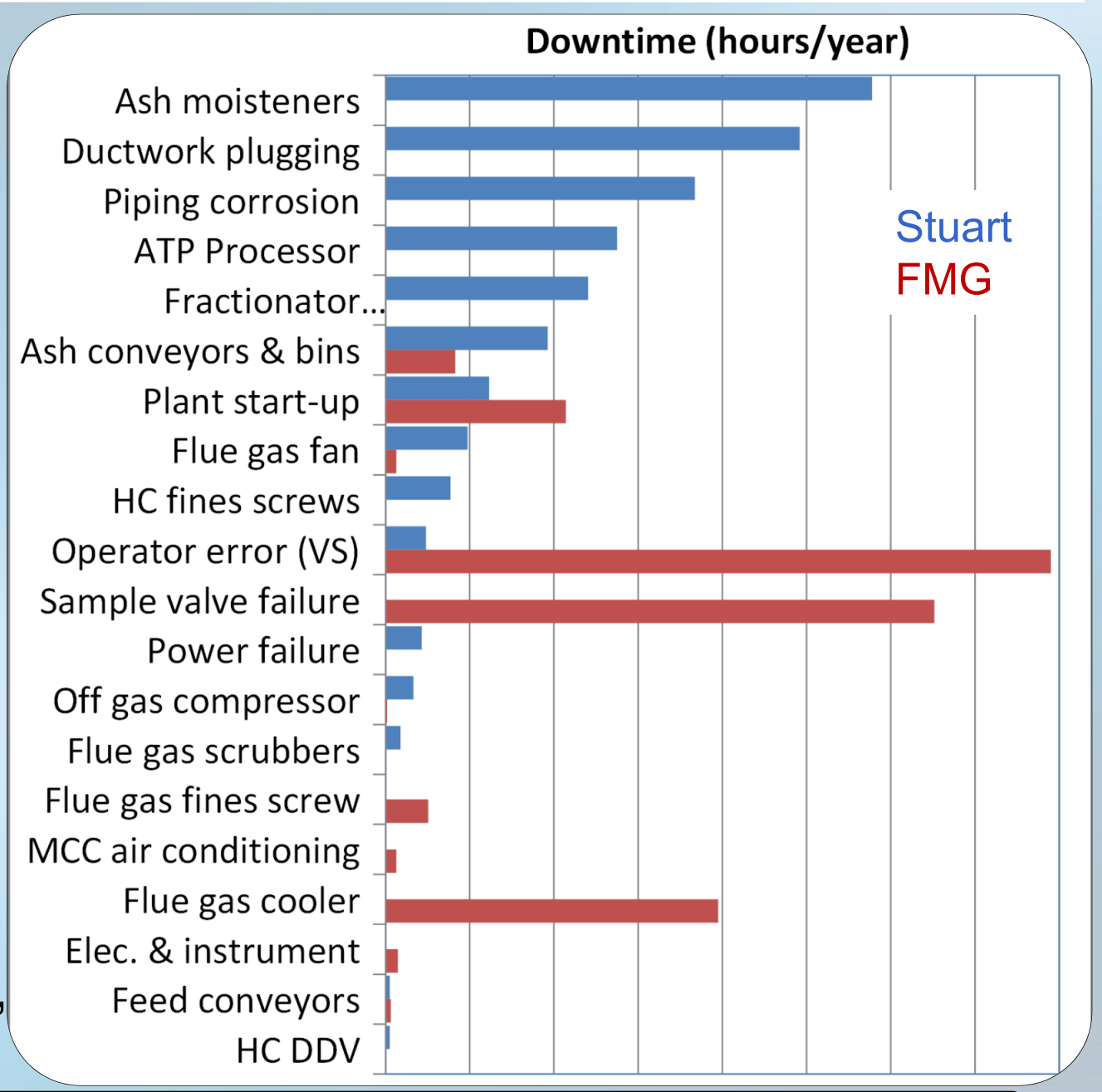
- → Operating error.
- → Sample valve failure.

Equipment performance:

- → Cooler fouling (solved).
- → Baghouse capacity.

Equipment quality:

- → Sample valve, flue gas fines screw, MCC air conditioning, electrical issues.



Learnings from Demonstration Plant Implemented; New Challenges at FMG.

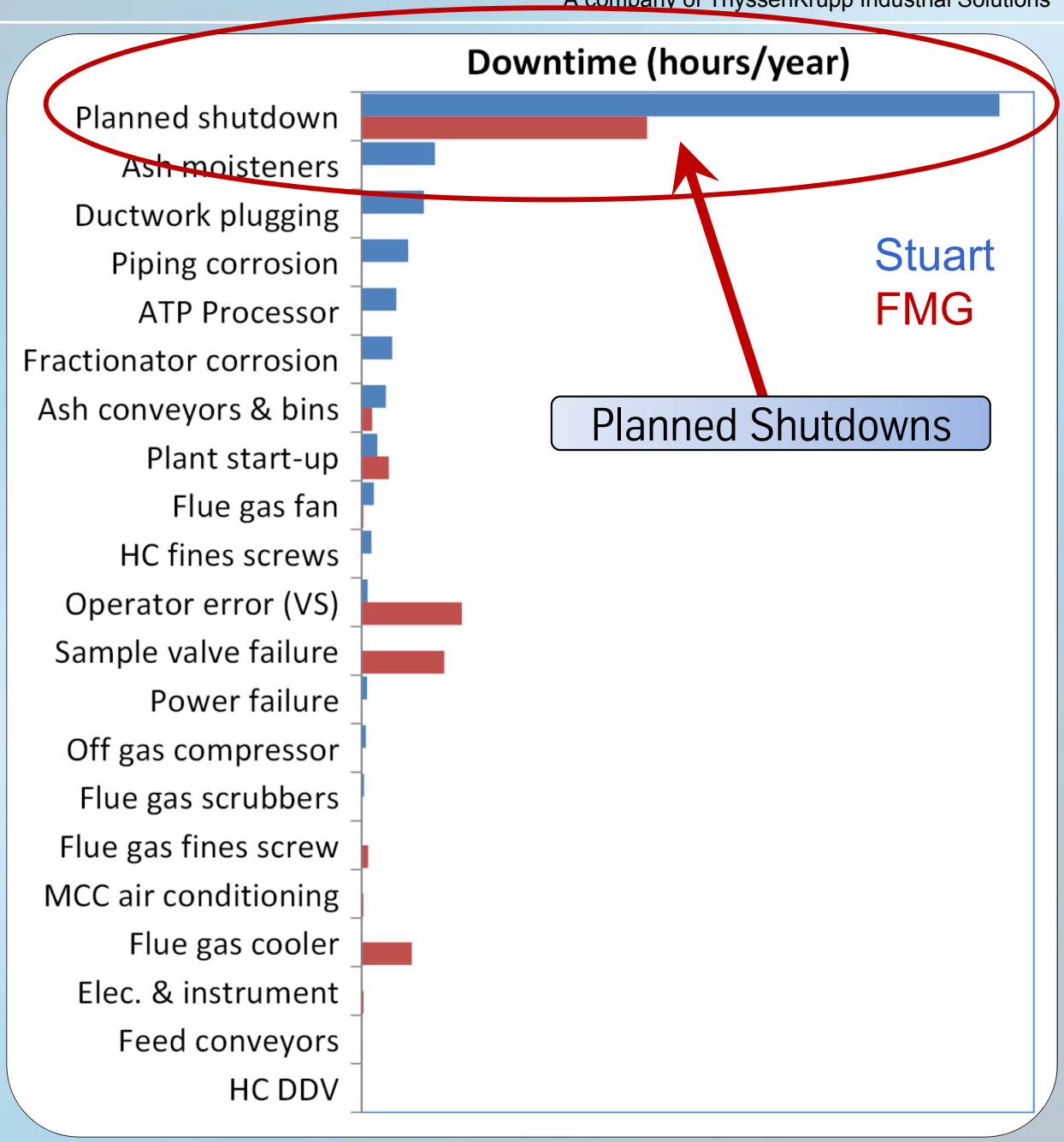
Total Downtime Comparison

Stuart Demonstration (2004)

- Lengthy planned shutdowns.
- Organizational constraints.
- ATP retort rear support routine maintenance usually the critical path.

FMG ATP Plant (2014/15)

- Turnaround duration greatly improved (target 10 days).
  - → FMG focus on turnaround performance!
  - → ATP retort rear support eliminated.
  - → Plant approaching design availability (85%).



Turnaround Time Significantly Reduced with Good Engineering and Planning

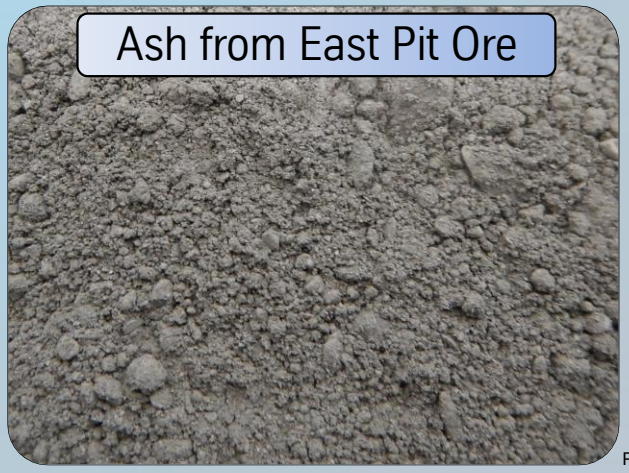
Value Added Processing

West Pit Mine is Closed.

- Pilot testing and design were done on West Pit ore: **7% oil yield, 5% free water.**
- Excellent particulate physical strength.

East Pit Opened – ore grade during early years of mine operation will be low.

- 2015 operations used East Pit ore. **4-7% oil, 5-8% water = low oil production.**
- Lower particulate physical strength, resulting in higher fines generation.



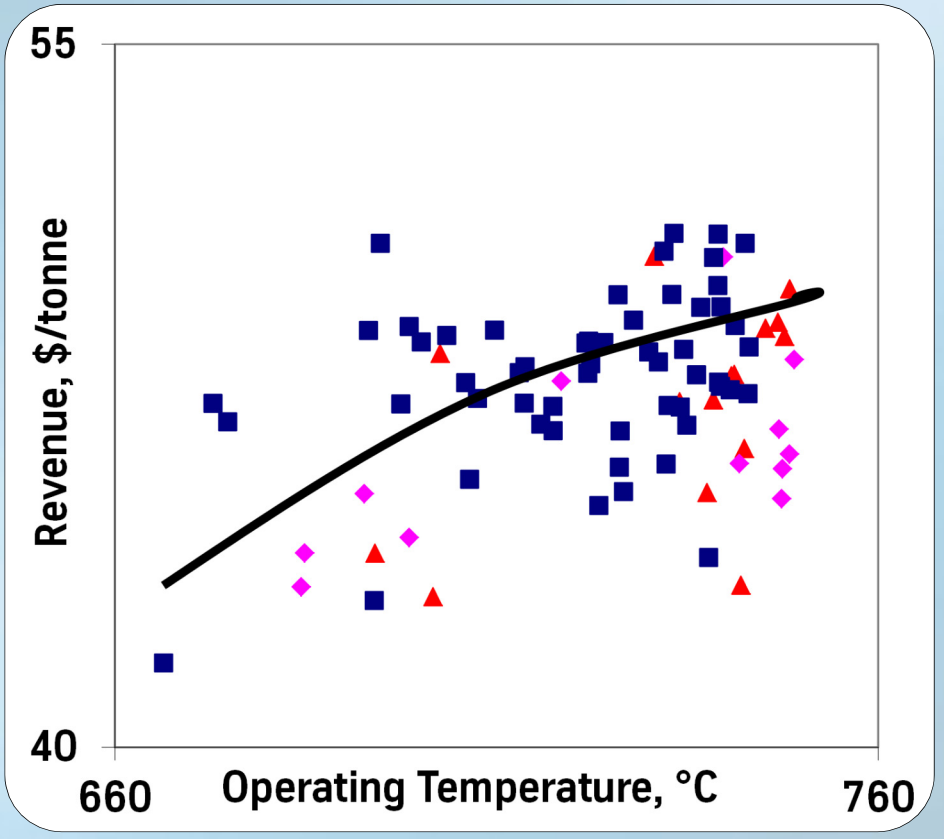
Value Added Processing

Oil Shale Processing:

- Maximize revenue & profit:
  - → Operate at highest availability.
  - → Minimize waste disposal cost & OPEX.
  - → Overall yield vs. most valuable yield.
    Maximum yield ≠ maximum revenue.

Other Opportunities:

- Large scale pyrolysis system, oil recovery system, infrastructure in place.
- Other readily available hydrocarbon bearing materials?
  - → Charge to process material (e.g. oilfield wastes): $/tonne feed processed.
  - → High oil yield feedstocks (e.g. rubber, plastic): $/bbl oil produced.
- Expend minimal capital, don't impact existing plant operability.




Used Rubber Tire

Example – Used Tire Pyrolysis

Addition to Existing Oil Shale Pyrolysis Plant:

- Low grade East Pit ore:
  → 2000 bbl/d from 2500 bbl/d plant.
- **Fushun oil shale ore yields 50 to 80 L/t**
- **Used rubber tire yields 575 L/t**
- Zillions of used tires in Shenyang/Fushun region.
- Process 120 t/d of tires = 3.7 million tires/year.

Revenue: $8 to 24 MM/a

- Environmental fee $4/tire = $15.0 million/a
- 20 t/d of steel @ $250/t = $ 1.5 million/a
- 375 bbl/d oil, @ $35/bbl = $ 4.0 million/a
- 7 MWt gas → 2 MWe = $ 1.8 million/a
- 11 MWt coke → 3 MWe = $ 2.2 million/a
  (displaces current fuel gas use).

Cost to collect tires is major expense. "Tire Tax" is incentive for recyclers in some jurisdictions.

Tire derived oil improves quality of Fushun raw shale oil product.

Example – Used Tire Pyrolysis

Addition to Existing Oil Shale Pyrolysis Plant:

CAPEX: $5-10 MM

- Stockpiles, shredding, conveying systems.
- No additional CAPEX for pyrolysis system.

OPEX: $5-10 MM/a

- Tire collection: $6-10 MM/a (location specific)
- Shredding system: $2 MM/a

Revenue: $8-24 MM/a (location specific)

Environmental benefit: Small, polluting "Illegal tire oil extraction" pyrolysis plants displaced.

Tire Shred Feed Hopper

Standalone Tire Pyrolysis Plant:

CAPEX: $30 to 80 MM

- Shredding, pyrolysis, coke processing plants; product shipping, utilities, offices, maintenance shops, fire protection…)

OPEX: $12-30 MM/a

Revenue: $13- 29 MM/a (carbon +$9, gas -$4 MM/a)

Standalone facility = $30 to 80 MM CAPEX. Shale plant add-on < $10 MM

Summary

Availability:

- ATP plant availability >80% (target 85%).
- Run length >100 days (target 90 days).
- Maintenance turnaround ~10 days.

Throughput:

- Plant has reliably achieved > 90% of plant design oil shale feed rate.
- ATP Processor is working well & handling ore much different than design.

Opportunities:

- Price of oil & low grade oil shale are economic challenges.
- Further improving plant operation.
- Co-processing alternate feedstocks to increase revenue.

TKIS and FMG Operating Team

Questions?

谢谢　Thank You　شكرا

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