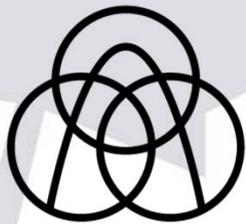


WORLD
HEAVY OIL
CONGRESS 2016
Calgary, Alberta, Canada

**The Alberta Taciuk Process
Its Advancements, Capabilities, and Advantages**



thyssenkrupp

UMATAC Industrial Processes

A company of thyssenkrupp Industrial Solutions

The Alberta Taciuk Process (ATP)

What does the Alberta Taciuk Process do?

1. Separates and recovers hydrocarbons from solids.
2. Pyrolyzes the hydrocarbons in a manner similar to fluid coking.
3. Uses coke byproduct as fuel and recovers heat to achieve high thermal efficiency.



UMATAC / tkIS Commissioning Engineers



ATP Plant Operation in China





Oil Shale – Conversion of Kerogen to Hydrocarbon

- Commercial scale oil productions units.
- 230 t/h, 2,300 bbl/d plant operating in China.
- 250 t/h, 4,500 bbl/d demonstration plant in Australia.
- 500 t/h, 10,000 bbl/d per unit planned.



Oil Sand – Extraction and Upgrading of Bitumen

- Capacity up to 800 t/h, 10,000 bbl/d per unit.
- Oil or water wet, high or low grade ore.
- **Scaleable for small to medium scale operations.**
- **No extraction losses.**
- **Includes coking of bitumen.**



Environmental Remediation/Non-conventional

- Capacity from 5 to +250 t/h per unit.
- Oil field/heavy oil/refinery/PCB/PAH contamination.
- End-of-life rubber tires, coal devolatilization.
- Hydrocarbon free tailings, energy efficient, oil product recovered for re-use.

thyssenkrupp Industrial Solutions (tkIS) - 19,000 employees

Material
handling &
crushing

ATP system,
high-temp
processing

Minerals
processing &
cement

EPC,
upgrading,
refining, H₂,
gasification

Marine
Systems



- Suncor, CNRL,
- Syncrude,
- Shell Albion,
- Imperial Oil Kearn



- Crushers, conveyors,
- Stackers, reclaimers,
- Conditioning drums,
- Ore preparation plants

tkIS (Krupp Canada) is the largest supplier of material handling, crushing, and ore preparation plants to the Alberta oil sands.



tkIS UMATAC (Calgary)

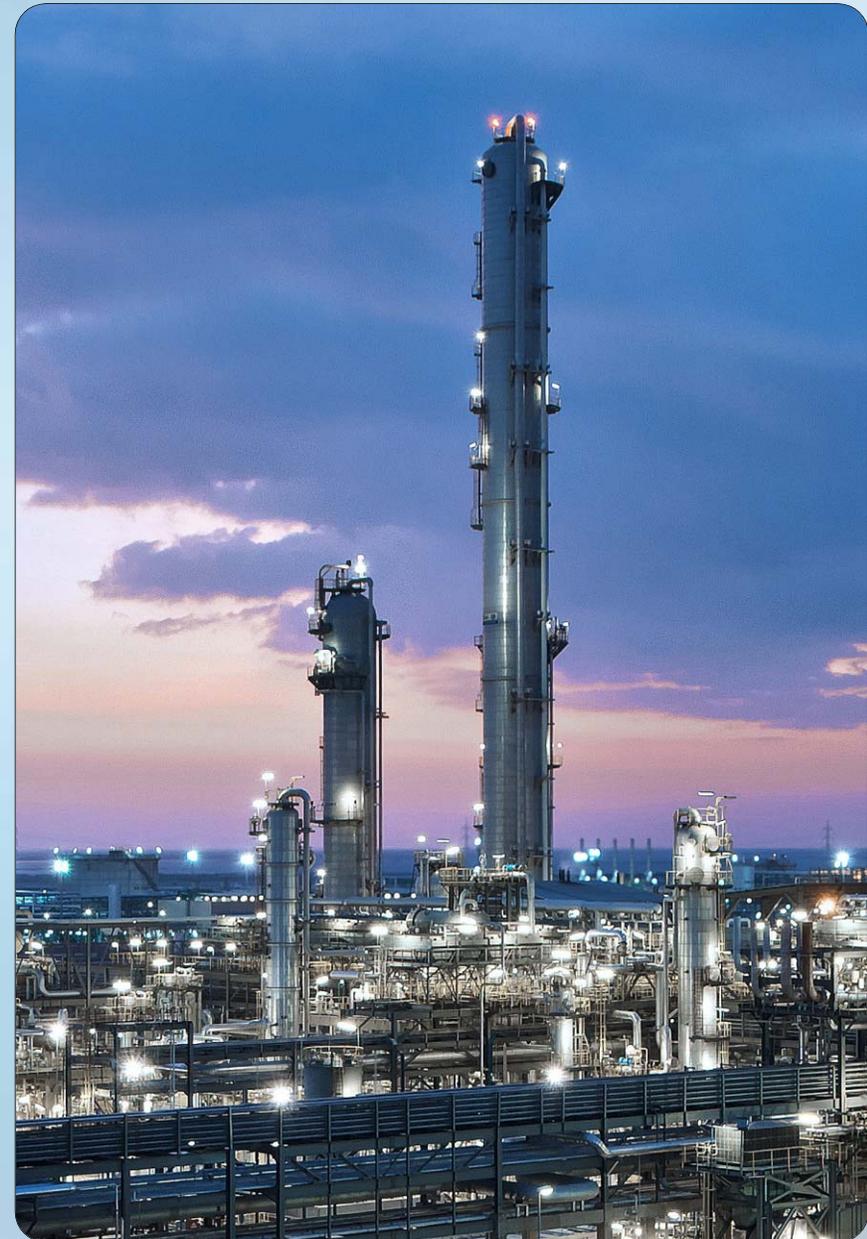
- ATP technology developer.
- Research & development centre.
- Engineering, project support.

tkIS Calgary (former Krupp Canada)

- Largest supplier of material handling, crushing, and ore preparation plants for the Alberta oil sands.
- Largest single project \$900 million EPC.

tkIS & thyssenkrupp (worldwide)

- Refining/process technologies (former Uhde).
- Material handling/mineral processing/cement.
- Engineering, materials, automotive, elevators.
- Heavy equipment fabrication.
- Regional representation and world-wide capabilities.



tkIS Oil & Gas



ATP Development History 1977 to 2016

Canadian technology:

- Originally partially funded by AOSTRA.
- Calgary based engineering office + R&D Centre.

Developed for oil sand (1980s-1990s):

- Direct pyrolysis of oil sand – **eliminates cokers.**
- Co-feed & **coking of SAGD bitumen.**
- Dry tailings - **simplifies mining plan.**
- **No tailings ponds.**

Commercialized for soil remediation (1990's):

- Operated in USA, Canada, 10 t/h capacity.
- Hydrocarbon free tailings, low emissions.

Scaled-up for mineable oil shale (2000+):

- 75:1 scale-up to 250 t/h capacity.
- 4,500 bbl/d demonstration plant in Australia:
 - ✓ Proved scale-up techniques & reliability.
- Design replicated in China for lower-grade oil shale:
 - ✓ Operating at > 85% availability.



ATP Pilot Plant, Calgary



ATP Technology – Scaled-Up for Oil Shale

The ATP was scaled-up to 250 t/h capacity for mineable oil production.

The **250 t/h ATP demonstration project** in Australia was the first large scale ATP.

- ✓ Proved the engineering & scale-up methods.
- ✓ Proved yield & product quality projections.
- ✓ Provided data for future improvements.
- ✓ 2.6 million tonnes of oil shale were processed.

The second large scale ATP was the **230 t/h Fushun Mining Group ATP Project**, now operating in China.

- ✓ Implemented improvements from demo project.
- ✓ Proved fabrication methods to allow lower cost construction of machines up to 800 t/h.
- ✓ High plant availability.

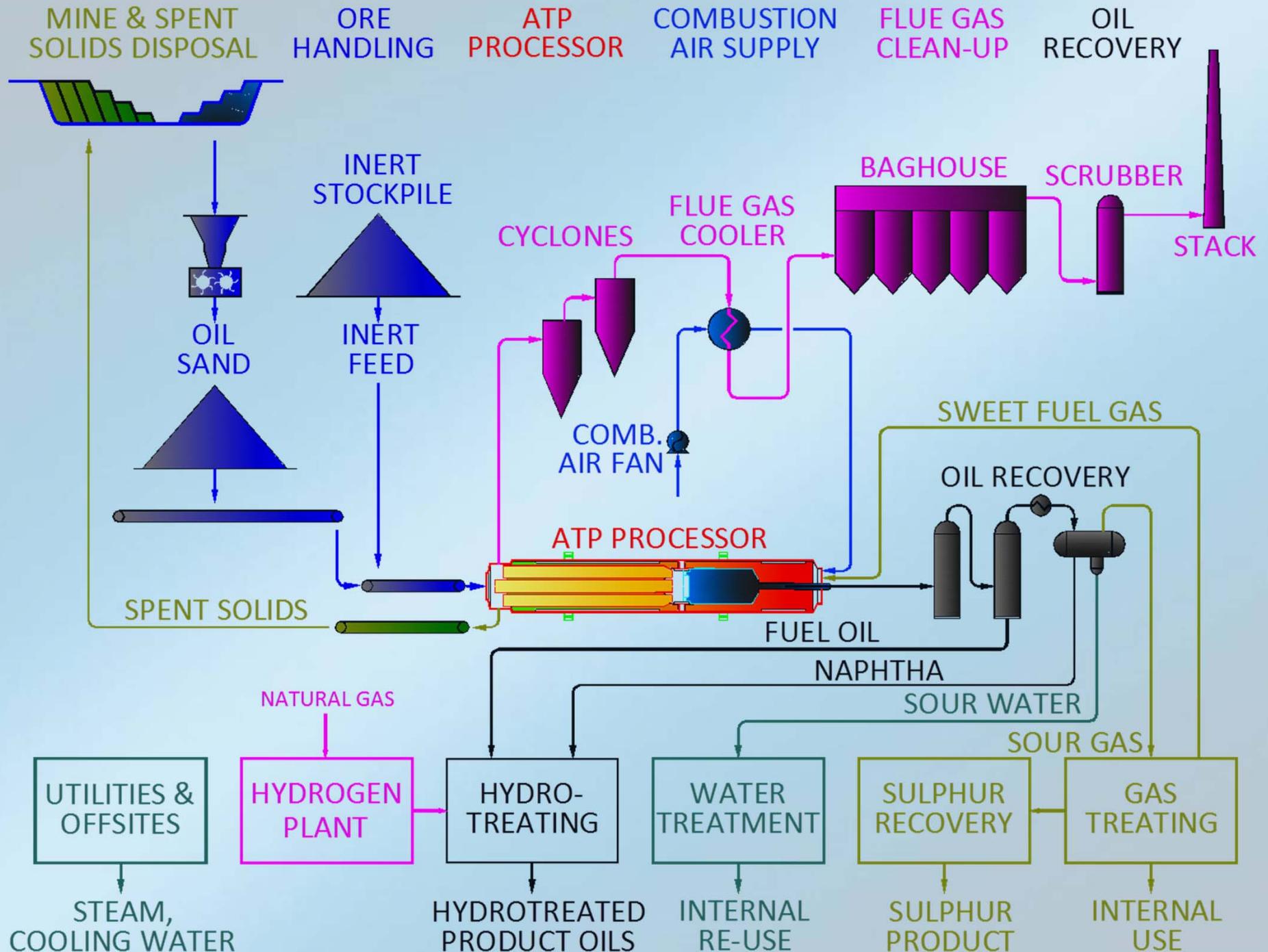
**5.0 million tonnes of ore processed and
2.3 million bbl oil produced to date.**



ATP Oil Recovery System,
China



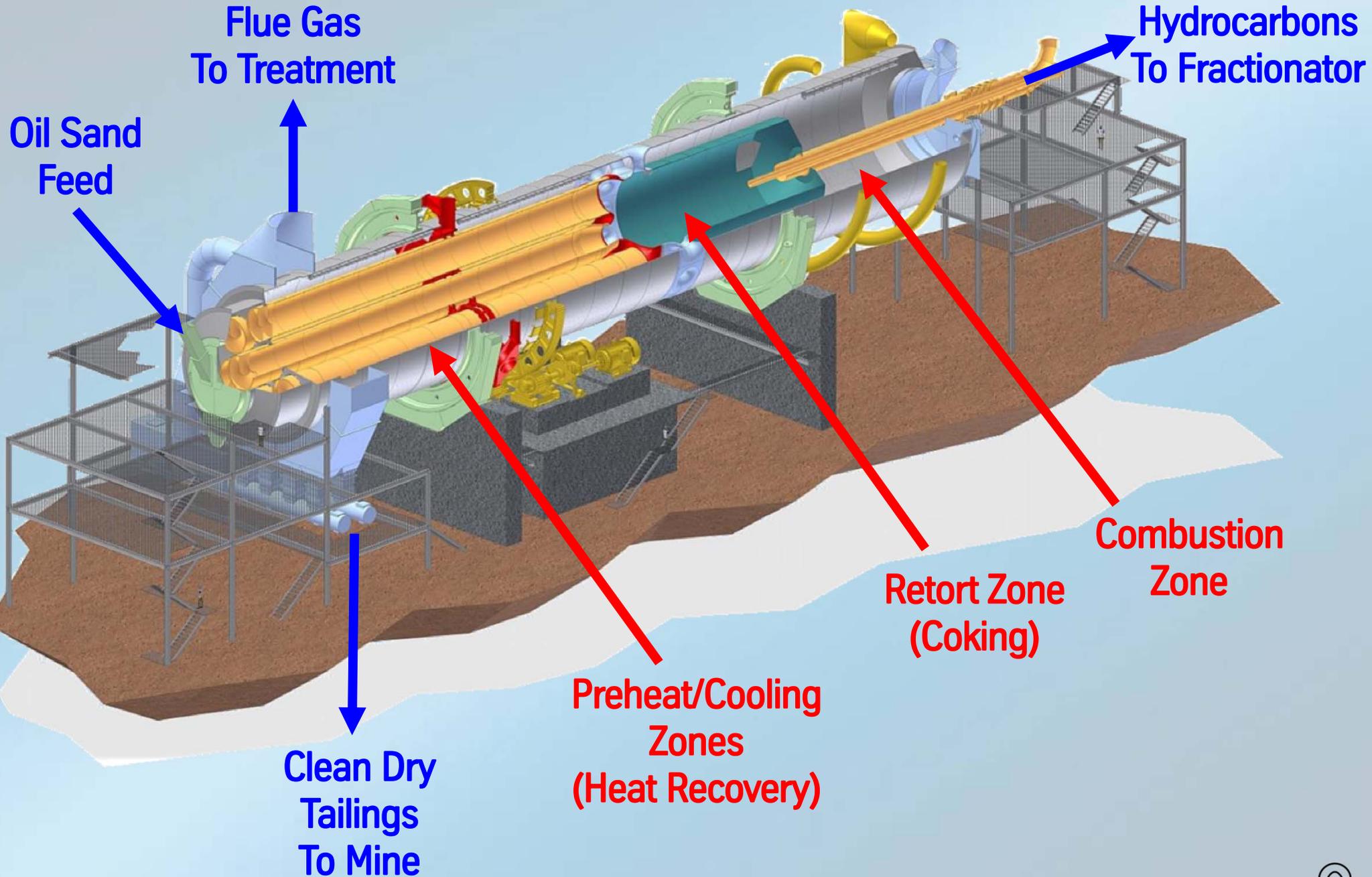
ATP Plant Flowsheet



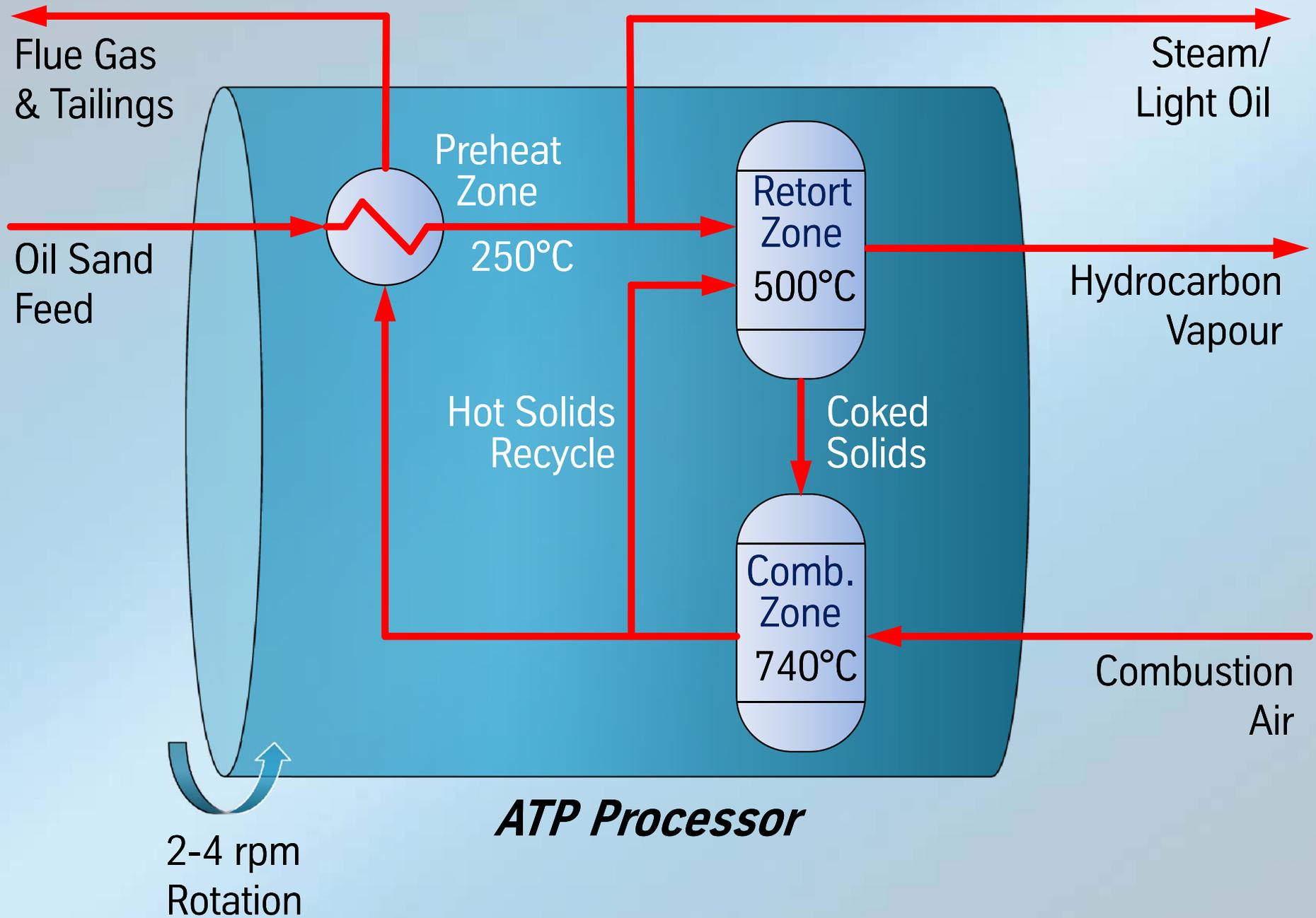
ATP Plant Flowsheet

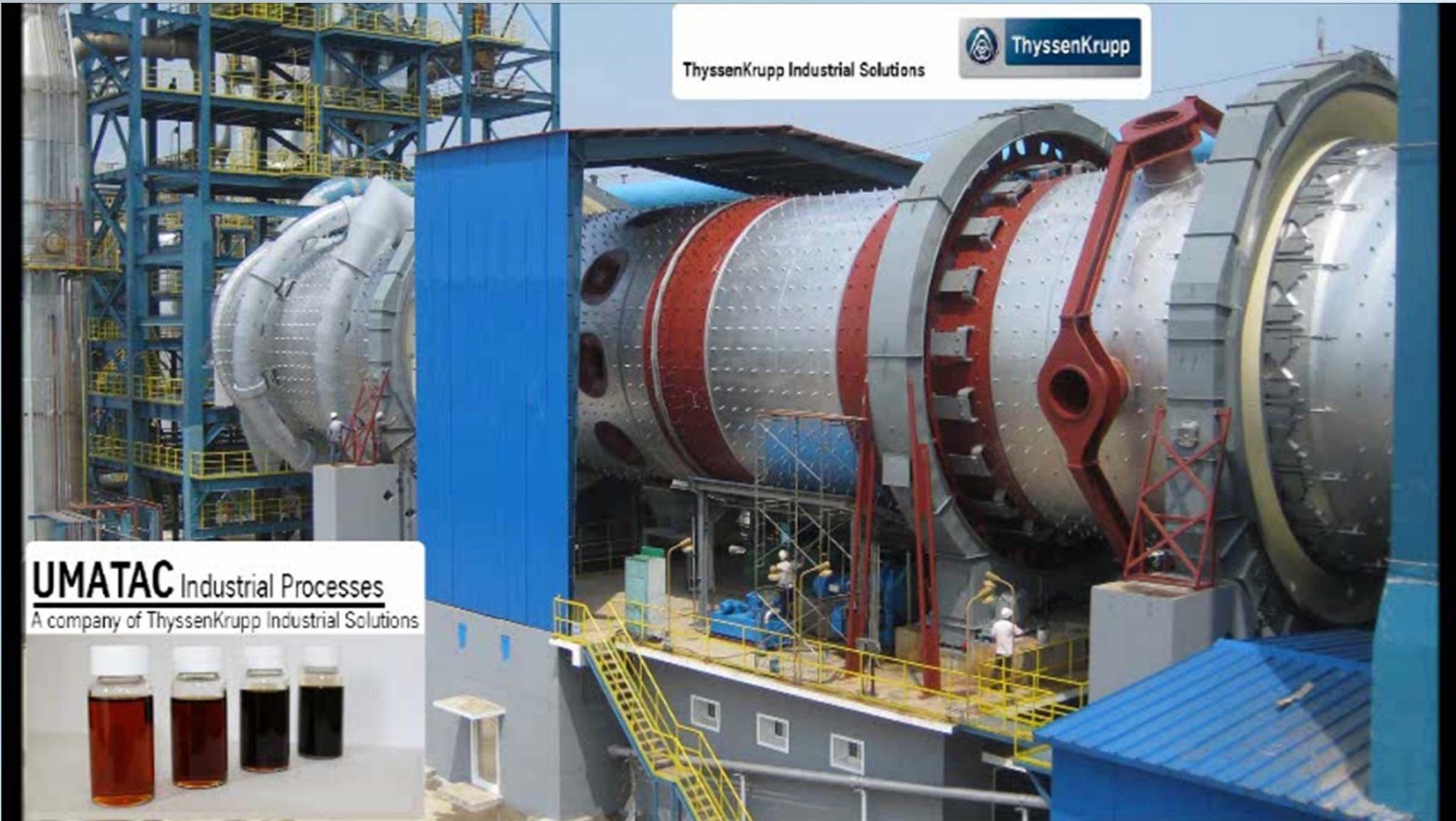


ATP Processor Arrangement



ATP Processor Flow Diagram



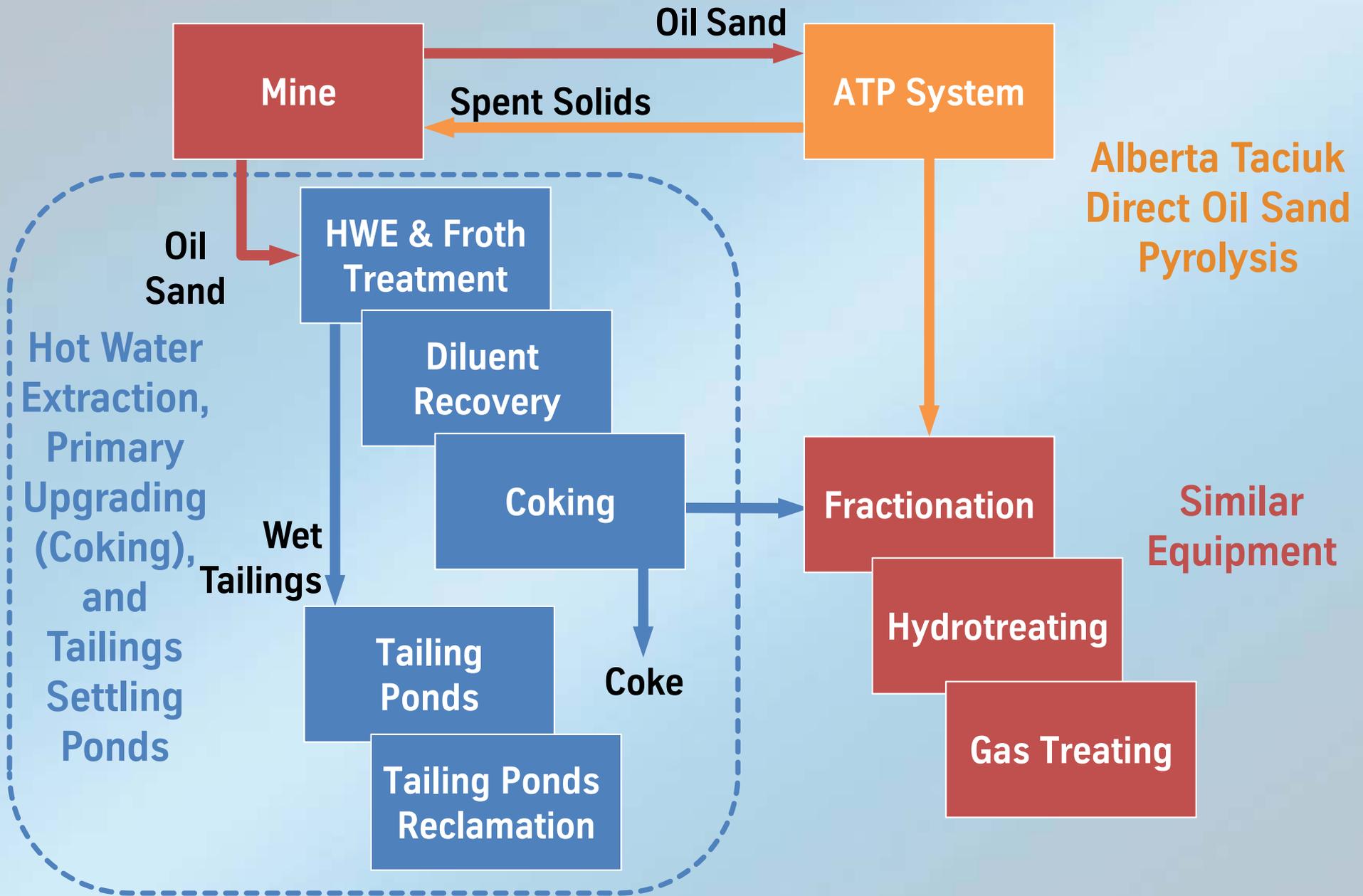


2014 Video – ATP Plant Operation (China)

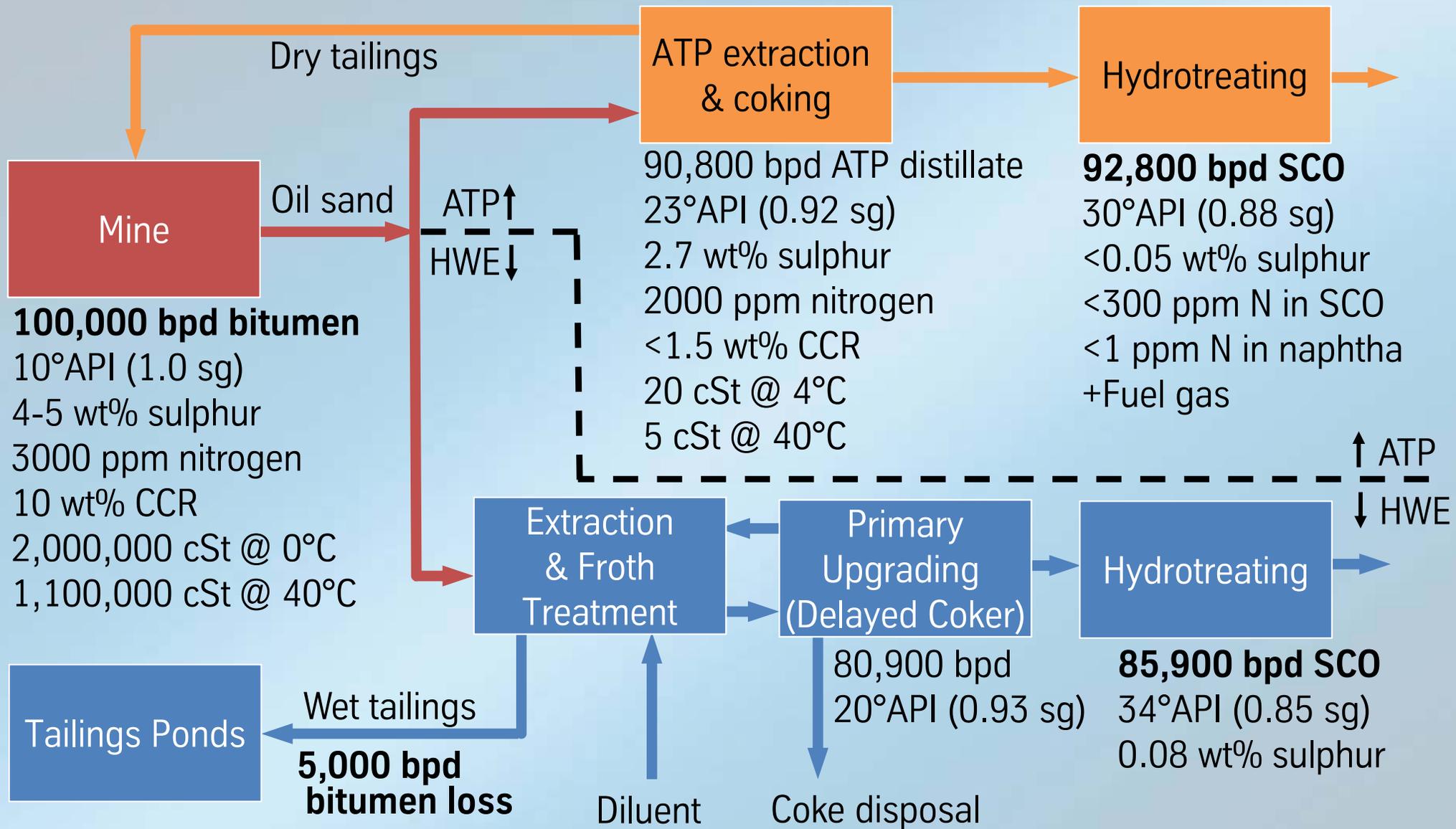
<http://youtu.be/XxNLUK6DLuE>



Oil Sand – Comparison of ATP vs. HWE/Coking



Comparison of ATP vs HWE+Delayed Coking

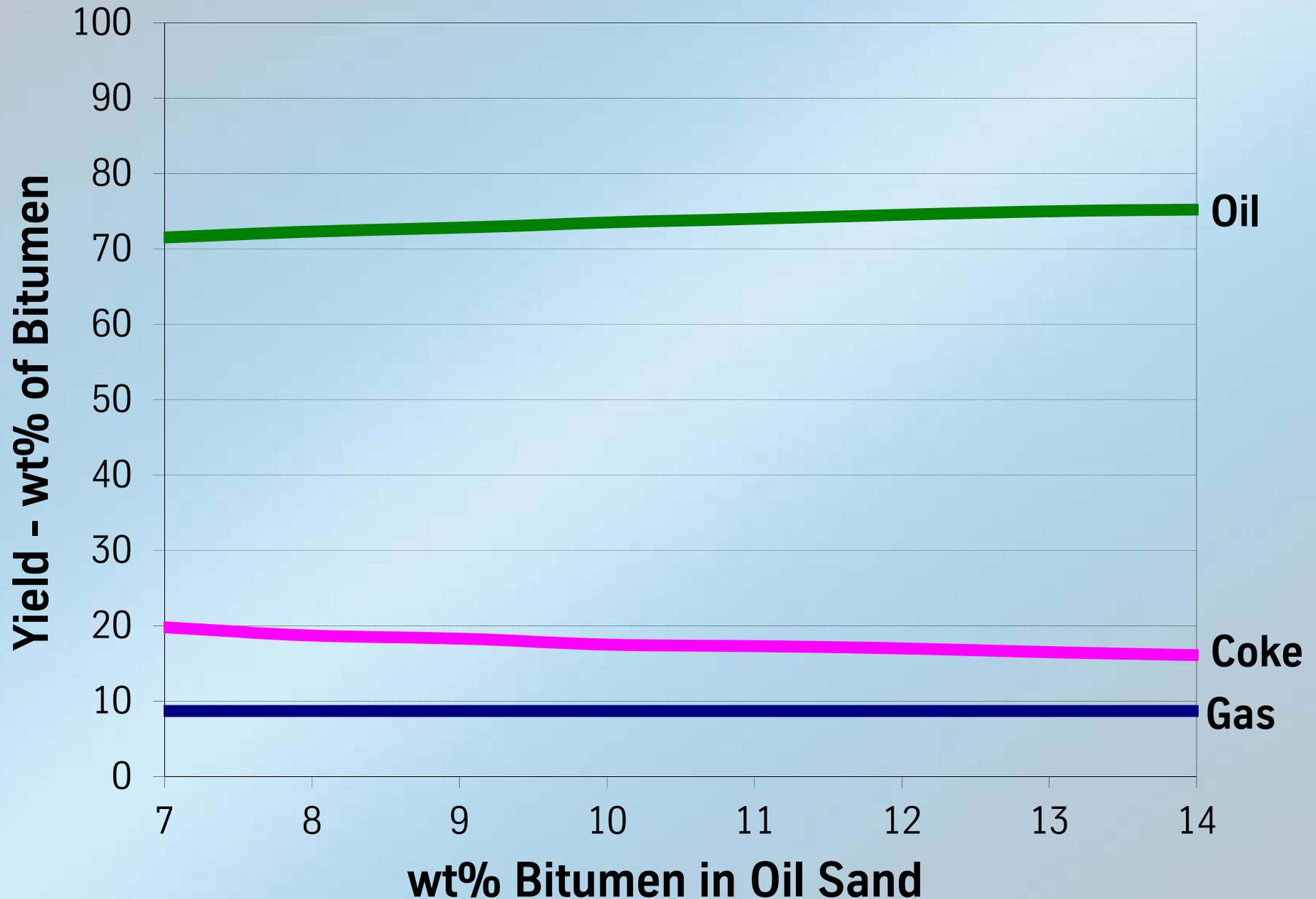


ATP has no extraction losses & includes bitumen coking.



ATP Products Yield Distribution

High yield of coked oil product from all ore grades; insensitive to water chemistry



Comparison of Products Before Upgrading

	Raw bitumen	HWE/fluid coking of bitumen	ATP distillate
API gravity	8.0	24	23
Sulphur, wt%	4.9	3.5	3.3
Nitrogen, wt%	0.4		0.2
Viscosity @ 40°C, cSt	1,100,000	5	5
Hydrotreater hydrogen consumption, scf/bbl		885	900-950
Distillation			
IBP-204°C	1.6	21.5	23
204-343°C	13.8	32.7	33
343-525°C	37.5	45.8	44
525+°C	47.1	0	0
Comments:	Viscous and high CCR	Low viscosity, thermally cracked, and bottomed.	ATP distillate is similar to fluid coker product oil.





CANMET Hydrotreating Results

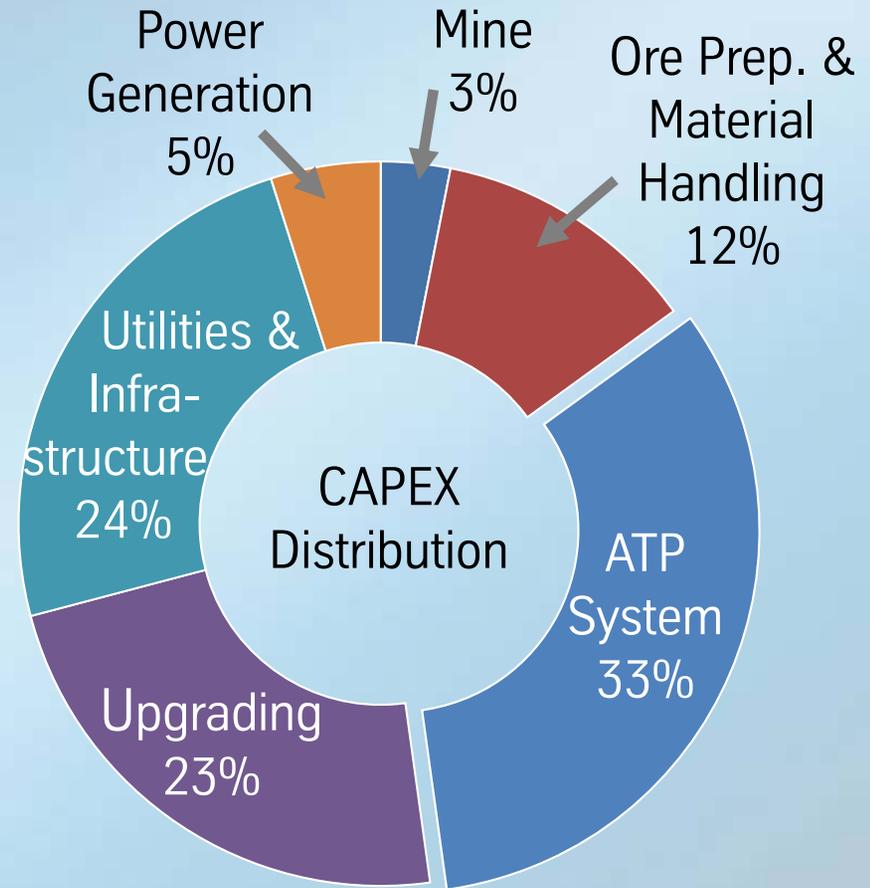
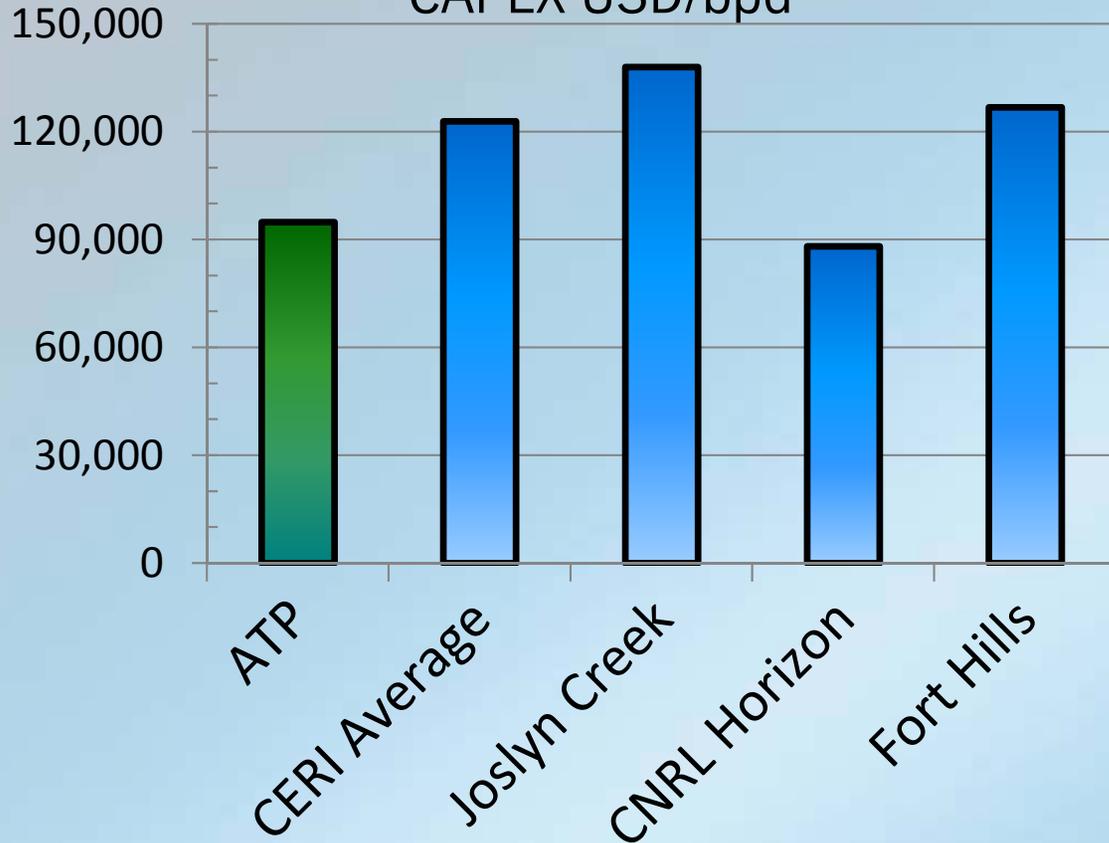


	Before Upgrading	After Upgrading
Density, g/mL (API)	0.92 (23 API)	0.88 (30 API)
Sulphur, wt%	3.3	< 0.05
IBP-204°C, %	23	20
204-343°C, %	33	36
343-525°C, %	44	44

Conventional hydrotreating works well.
Stabilize, reduce sulphur, control nitrogen in naphtha fraction.

CAPEX – Oil Shale Project Example

Standalone ATP Plant with upgrading to SCO
CAPEX USD/bpd



ATP project costs are comparable to similar oil sand projects.

ATP technology block is only one-third of the project!

Addition of ATP to existing HWE oil sand plant to process difficult ores could share upgrading/infrastructure, reducing costs to <\$40,000/bpd



	ATP60 & Pilot Plant 1978+	SoilTech 1990 -1995	Stuart Stage 1 1999-2004	FMG Stage 1 2013+	Jordan Phase 1 (future)
Feedstock	Oil sand	Hydrocarbon contaminated soils	Australian oil shale	Chinese oil shale	Jordanian oil shale
ATP Processor size	5 t/h	10 t/h	211 t/h	230 t/h	2 x 500 t/h
Feed composition					
Water	8 wt%	10 - 30 wt%	8 wt%	5 wt%	3 wt%
Hydrocarbon	10 wt%	0 - 20 wt%	25 wt%	15 wt%	23 wt%
Oil production	60 bbl/d	0 - 225 bbl/d	4,500 bbl/d	2,500 bbl/d	17,500 bbl/d
Products	<ul style="list-style-type: none"> • Naphtha • Fuel oil • Fuel gas 	<ul style="list-style-type: none"> • Clean soil • Naphtha • Fuel oil • Fuel gas 	<ul style="list-style-type: none"> • Hydrotreated naphtha • Fuel oil 	<ul style="list-style-type: none"> • Naphtha • Fuel oil • Electricity 	<ul style="list-style-type: none"> • Synthetic crude oil • Electricity • Sulphur
Feed Processed, t	155,000 ⁽²⁾	102,500 ⁽¹⁾	2,500,000 ⁽¹⁾	2,200,000 ⁽²⁾	(future)
Oil Recovered, bbl	8,500	n/a	1,650,000	648,000	
Operating hours, h	35,200	25,000	25,000	17,400	

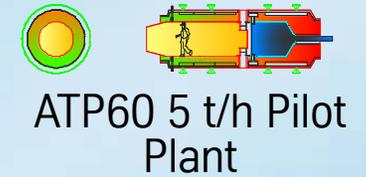
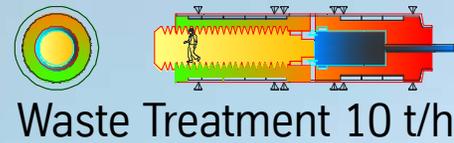
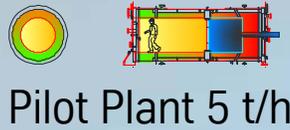
⁽¹⁾ Includes only production operations (excludes start-up/shut-down/hot-hold/commissioning operations).

⁽²⁾ Production values as of June 30, 2016.

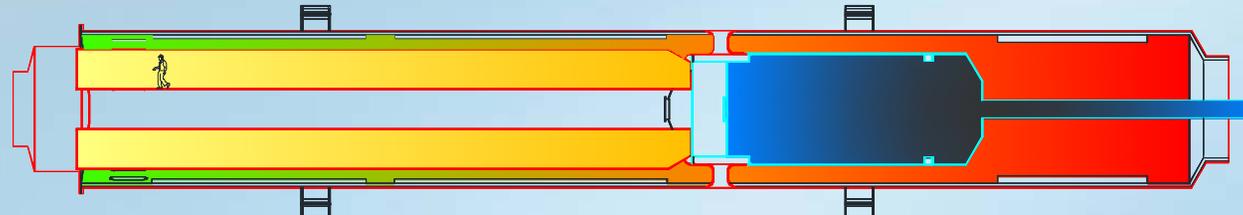
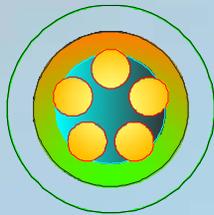


ATP Processor – Wide Range of Capacities

Canada/USA
5 to 10 t/h



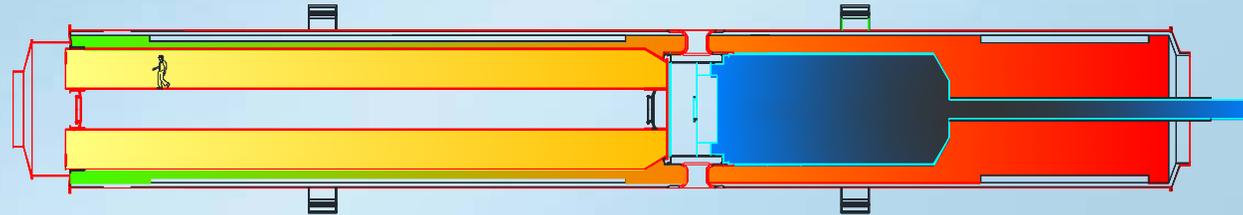
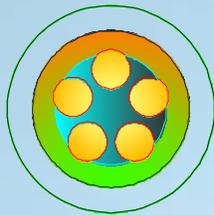
Australia
1997
211 t/h
8.3 m diameter.



170 LTOM oil shale ore, 4,500 bbl/d oil
Oil sand capacity 340 t/h (5,000 bbl/d)

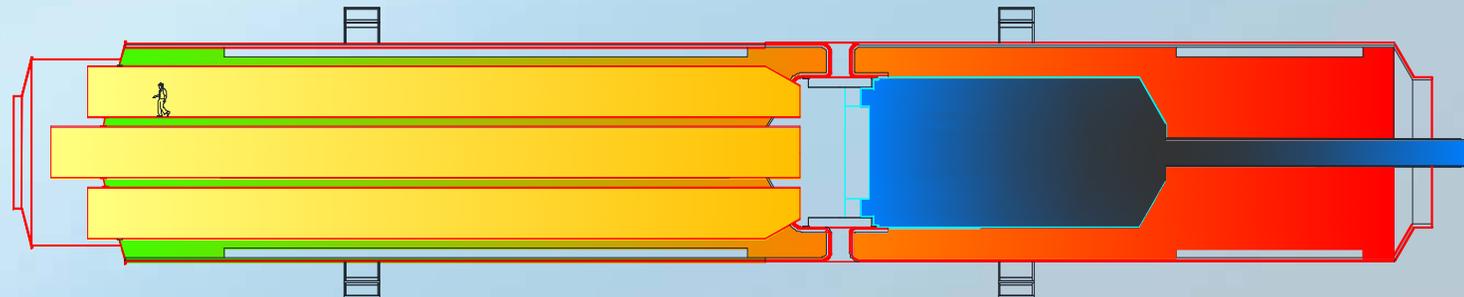
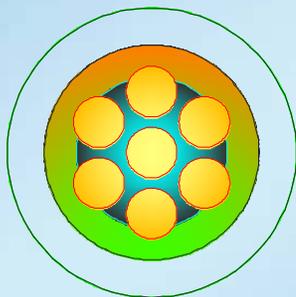
Note:
Processors have higher capacity on oil sand than on oil shale due to higher density of oil sand ore.

China
2006
230 t/h
8.3 m diameter.



80 LTOM oil shale ore, 2,500 bbl/d oil
Oil sand capacity 370 t/h (5,100 bbl/d)

Jordan
Future
500 t/h
11.5 m



132 LTOM oil shale ore, 8,750 bbl/d oil
Oil sand capacity 800 t/h (11,000 bbl/d)



ATP Demonstration Project, Australia

211 t/h ATP (250 t/h feed to dryer), 170 LTOM ore (25% oil/gas/coke yield),
4,500 bbl/d oil production, hydrotreated naphtha <1 ppm S, <4 ppm nitrogen.



Demonstration plant proved technical basis, scale-up, and operation of ATP



Fushun Mining Group ATP Project, China

230 t/h ATP, low grade 60-80 LTOM oil shale (15% oil/gas/coke content),
2,500 bbl/d oil production.



Plant achieved 91% availability for first six months of 2016,
87% for 12 month period June 2015-June 2016.

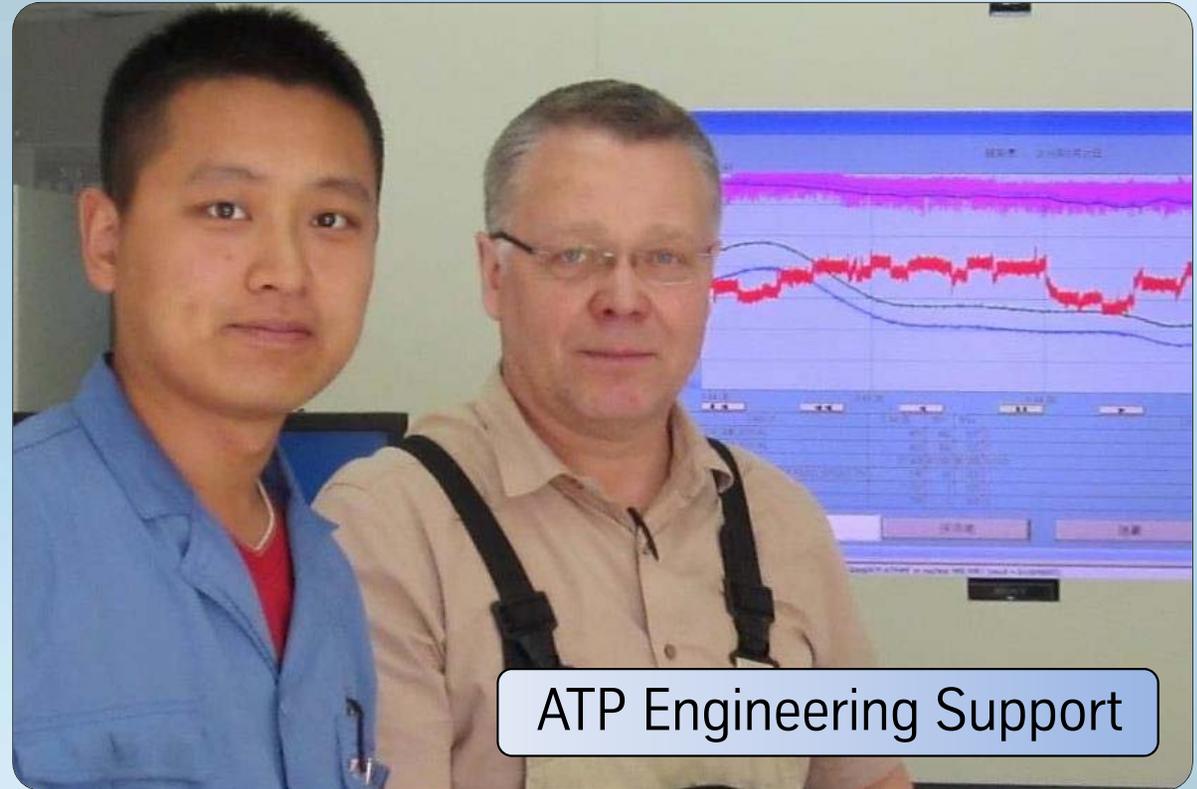


Excellent Availability

- 115 day run length achieved.
- 87% overall plant availability (>100% of design target).
- 90-100 days operation, 10 day maintenance turnaround.

Challenges:

- **Bottlenecks/Reliability**
 - 90% of design feed rate due to baghouse restriction.
- **Low ore grade from mine.**
 - Low grade = low oil production.



ATP Engineering Support



ATP Plant Control Room



UMATAC ATP60 (5 t/h) Pilot + R&D Centre

ATP Pilot Plant – 60 bpd oil production on oil sand feed.



Calgary Research & Development Centre

UMATAC Industrial Processes
A company of thyssenkrupp Industrial Solutions

Internal (ATP) and External (Client Directed) Research





Specialist laboratory & research services





Small scale testing to verify performance

High Yield

- Yield consistent for low, medium, and high grade oil sand.
- Not sensitive to connate water chemistry, bitumen conditioning, and clays.
- Oil wet or water wet oil sand.
- No bitumen loss during extraction. No diluent required.

High Quality Products

- Low viscosity, bottomed oil product similar to that produced by fluid/delayed coking of bitumen.
- ATP product is olefinic, but readily hydrotreated to SCO.
- High diesel/gas oil fraction in product oil.
- High quality fuel gas.

Dry Tailings

- Direct backfill of tailings in mine – simplifies mine plan.
- No tailings ponds, less expensive remediation.
- Hydrocarbon free tailings.

**Main Plant Flare,
FMG ATP Plant,
China**



ATP Advantages for Oil Sand

Scalable & Versatile

- Amenable to incremental capacity expansion.
- Relatively small scale modules are low risk.
- Modules can be distributed.
- Can co-process miscellaneous feeds (e.g. tank sludges, asphaltenes, heavy oils, oil spills, etc.)

Low Natural Gas and Water Requirements

- By-product coke used as primary fuel source.
- Off gas is used as fuel for process plant.
- Water consumption is limited to tailings cooling, wet scrubbing, and evaporative cooling losses.

Cost Effective

- Capital and operating costs for greenfield ATP/upgrader are comparable to existing HWE/upgrader plants.
- Incremental capacity increase by ATP addition to existing oil sand operation has lower cost.

tkIS/UMATAC Engineers
- Germany



ATP Processor uses residual coke as process fuel

- Effective use of hydrocarbon pyrolysis by-product.
- Produced fuel gas available to other users.

ATP Processor operates at atmospheric pressure

- Inherently safe process.

ATP Processor uses solids for heat transfer

- High processing capacity per ATP unit.
- Stable process operation.

ATP Processor flue gases and tailings are separated from pyrolysis products

- Good environmental performance.
- Uses standard flue gas scrubbing technologies.

ATP Processor uses proven heavy machine design

- High reliability and mechanical availability.

Flue Gas Stack During Operation – FMG ATP Plant, China





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thyssenkrupp

AOSTRA	Alberta Oil Sand Technology Research Authority
ATP	Alberta Taciuk Process (formerly AOSTRA Taciuk Process)
ATP60	UMATAC's 5 t/h ATP Pilot Plant (60 bbl/d production on Oil Sands)
CCR	Conradson Carbon Residue
EPC	Engineer, Procure, Construct
FMG	Fushun Mining Group
HWE	Hot Water Extraction
LOI	Loss on Ignition
LTOM	Litres of Oil Per Tonne Of Zero Moisture Ore (t ZRM)
PAH	Polyaromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
SCF	Standard Cubic Foot
SCO	Synthetic Crude Oil
tkIS	thyssenkrupp Industrial Solutions
UMATAC	UMATAC Industrial Processes Inc., a company of thyssenkrupp Industrial Solutions AG

