


Dynamic Behaviour and Operational Flexibility of the ATP Processor

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A company of ThyssenKrupp Resource Technologies

ThyssenKrupp Resource Technologies

Mineable Oil

Shale oil(*) is mineable oil.

* Not that stuff they pump out of the ground

A good miner will deliver consistent feed to the process plant – but there will be variability.

The process plant must accommodate ore variability and provide sufficient flexibility to respond to operational challenges.

Shale oil production starts at the mine

Case Studies

Kerosene Creek Oil Shale

Free moisture	Design 24%	Actual 20-27%
After dryer	Design 8%	Actual 8 to 18%
Kerogen	Design 27%	
Horizons	A, B1, C1a.b.c.d.e, C2, D1, D2, E	
Other surprises	Siderite nodules	
	Thermal sensitivity during drying	
	Emission and oil quality impacts	

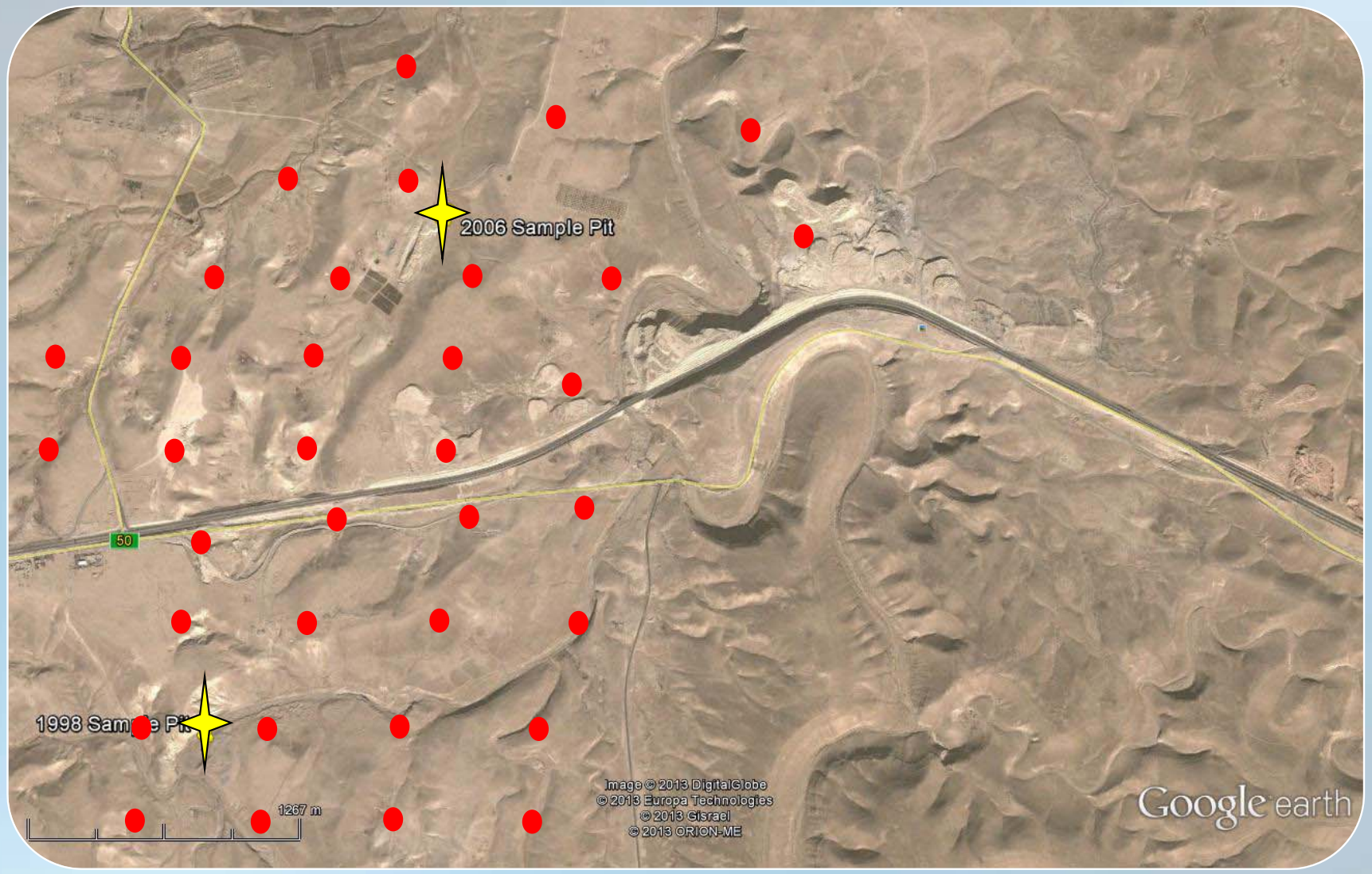
Tropical rainstorms (+100 mm per hour)

Al Lajjun Oil Shale

Free moisture	Design 3%	Actual 3-6% (100% variation)
Kerogen	Design 22%	Actual 15-26% and soluble bitumen present
Horizons	A0, A1, B, C, D, M	

The miners must deliver what the plant wants.
The plant must accept what the miners deliver.

Geological Variation



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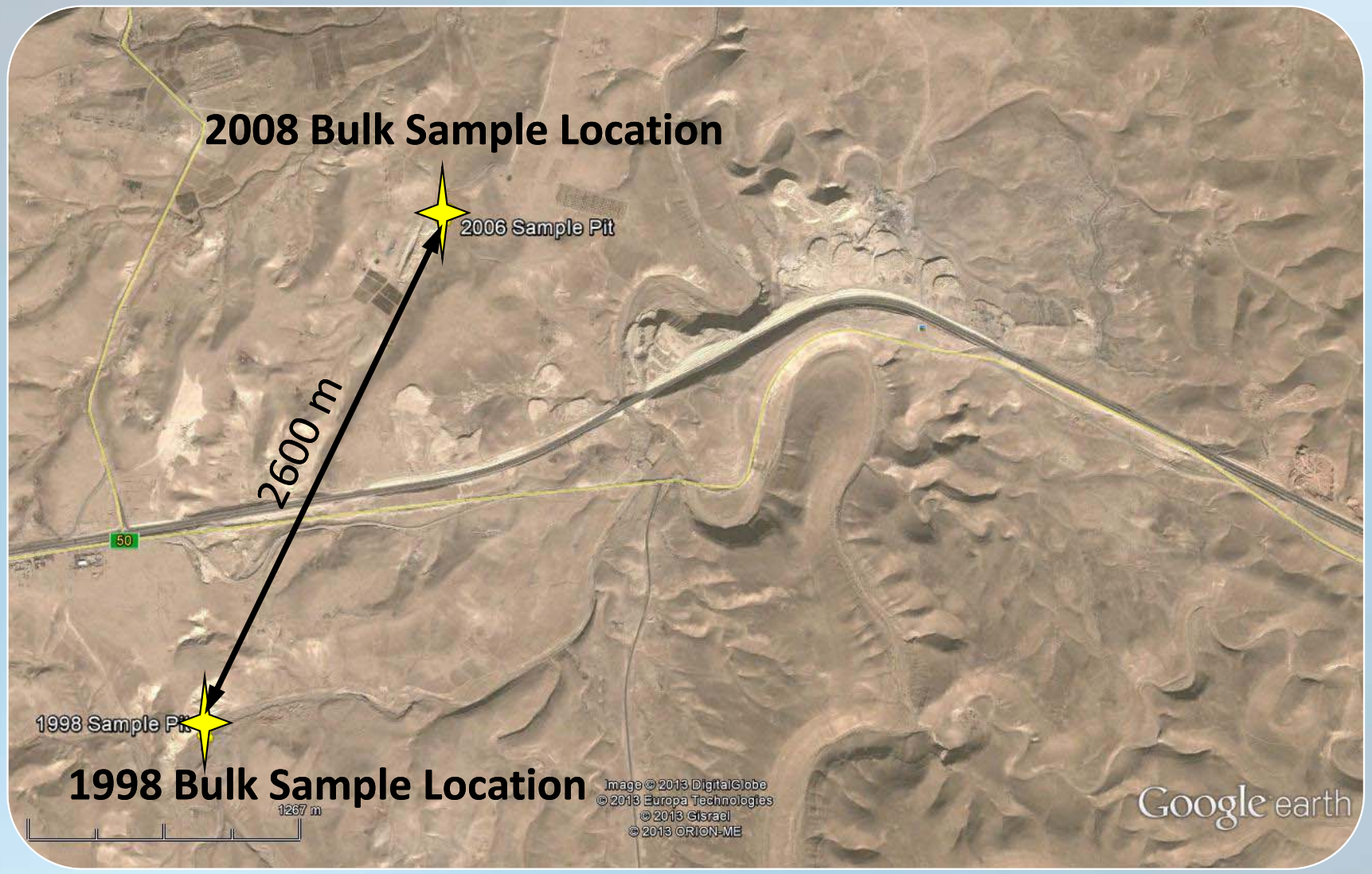
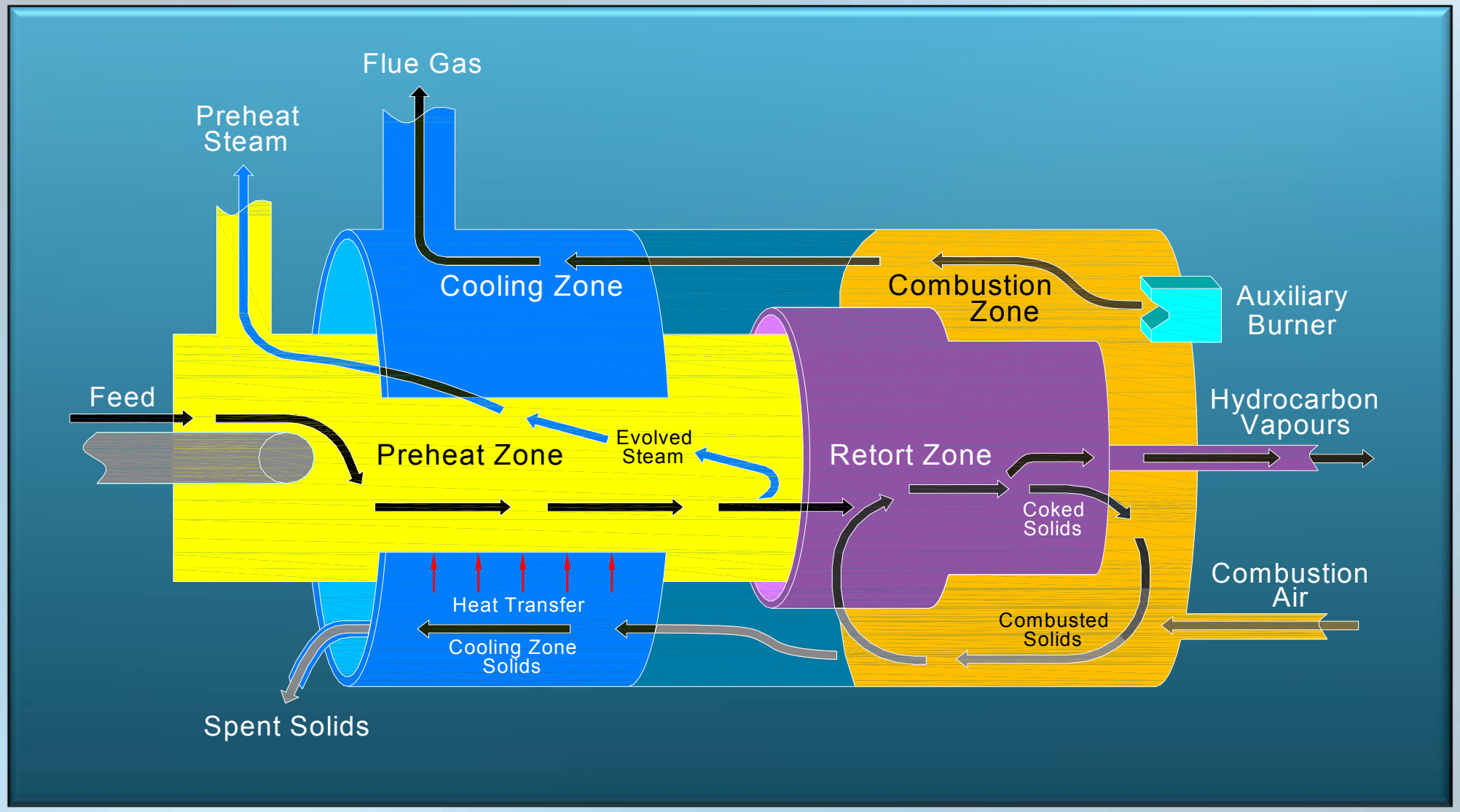
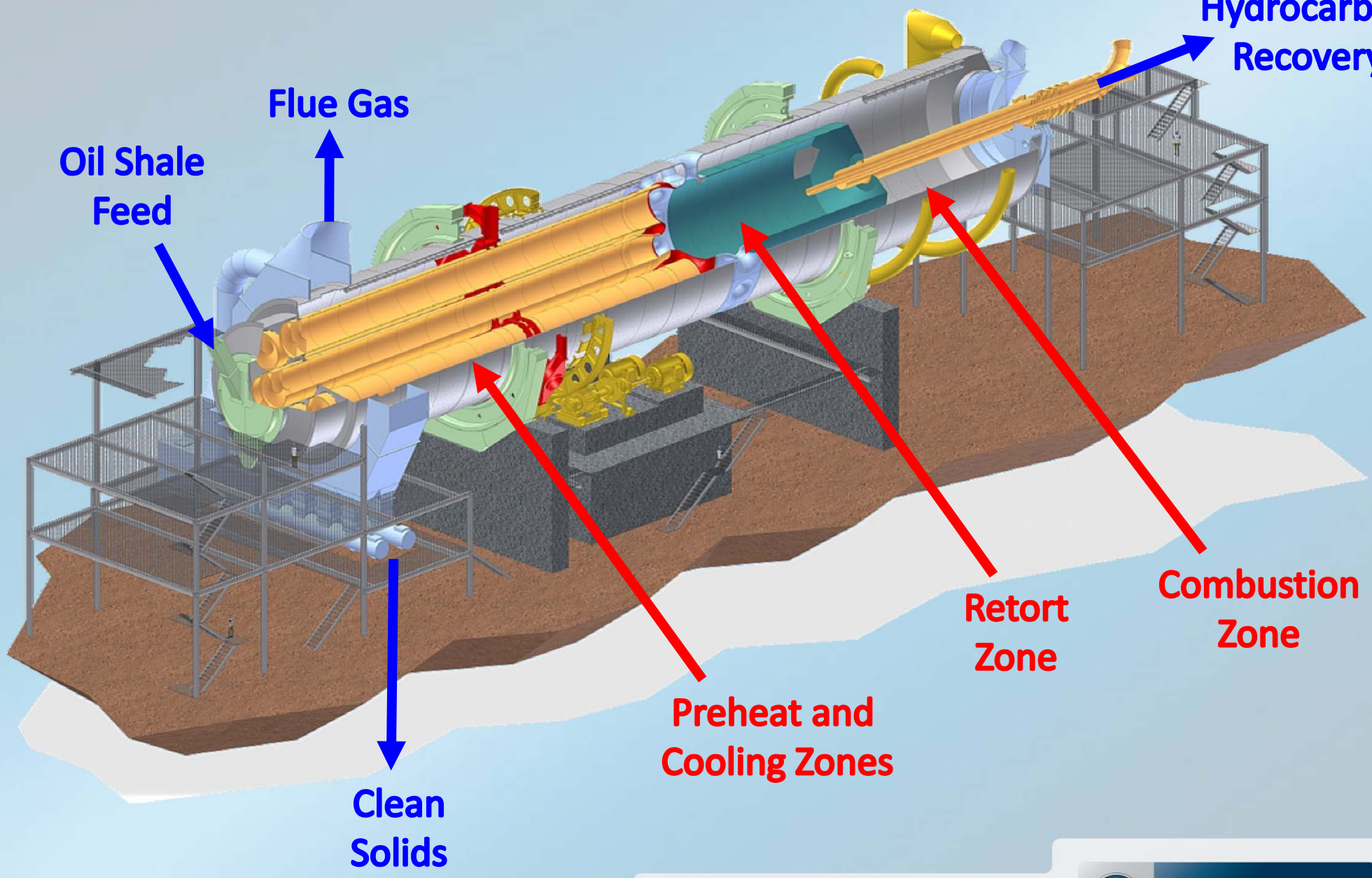


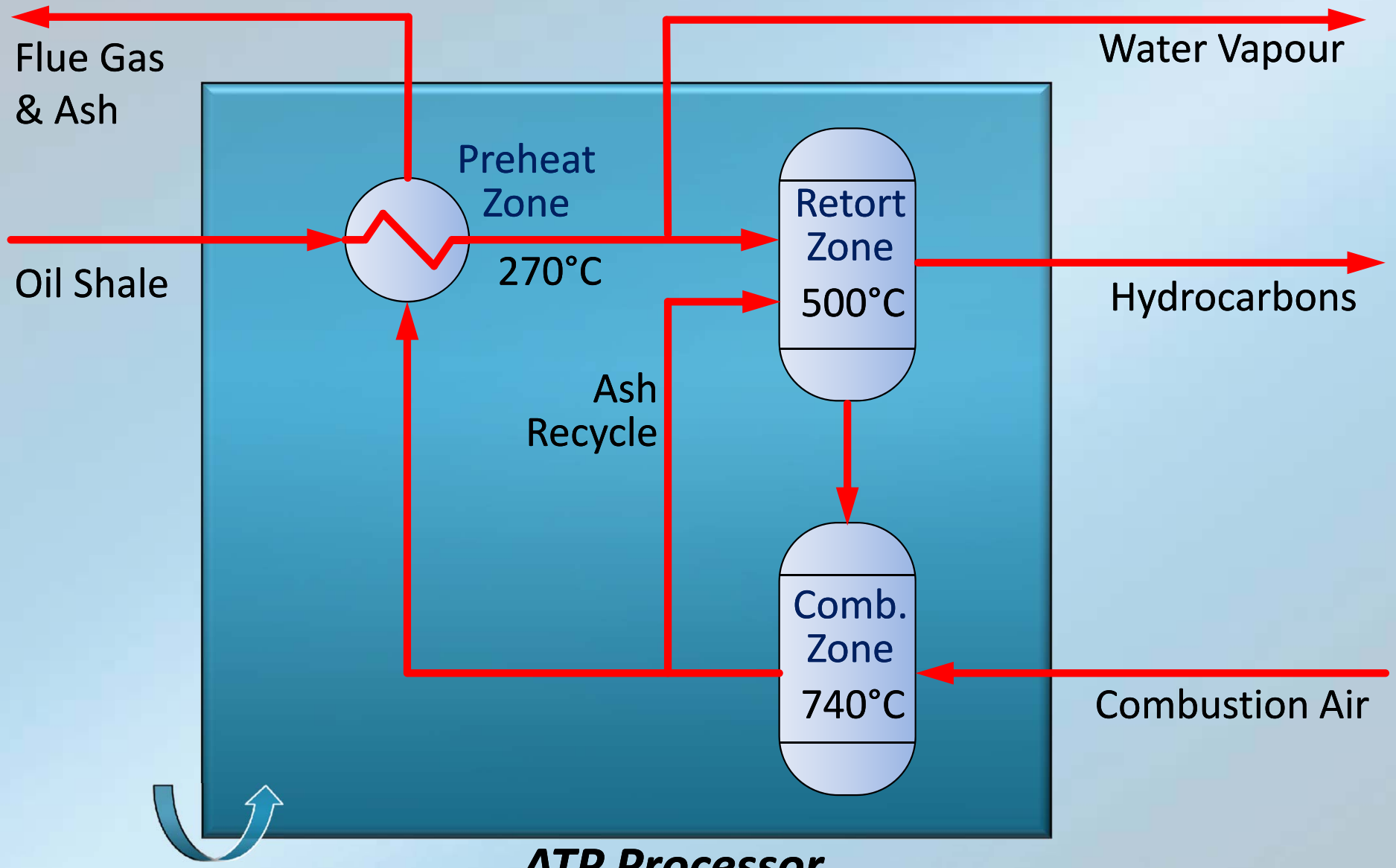
The ATP Processor



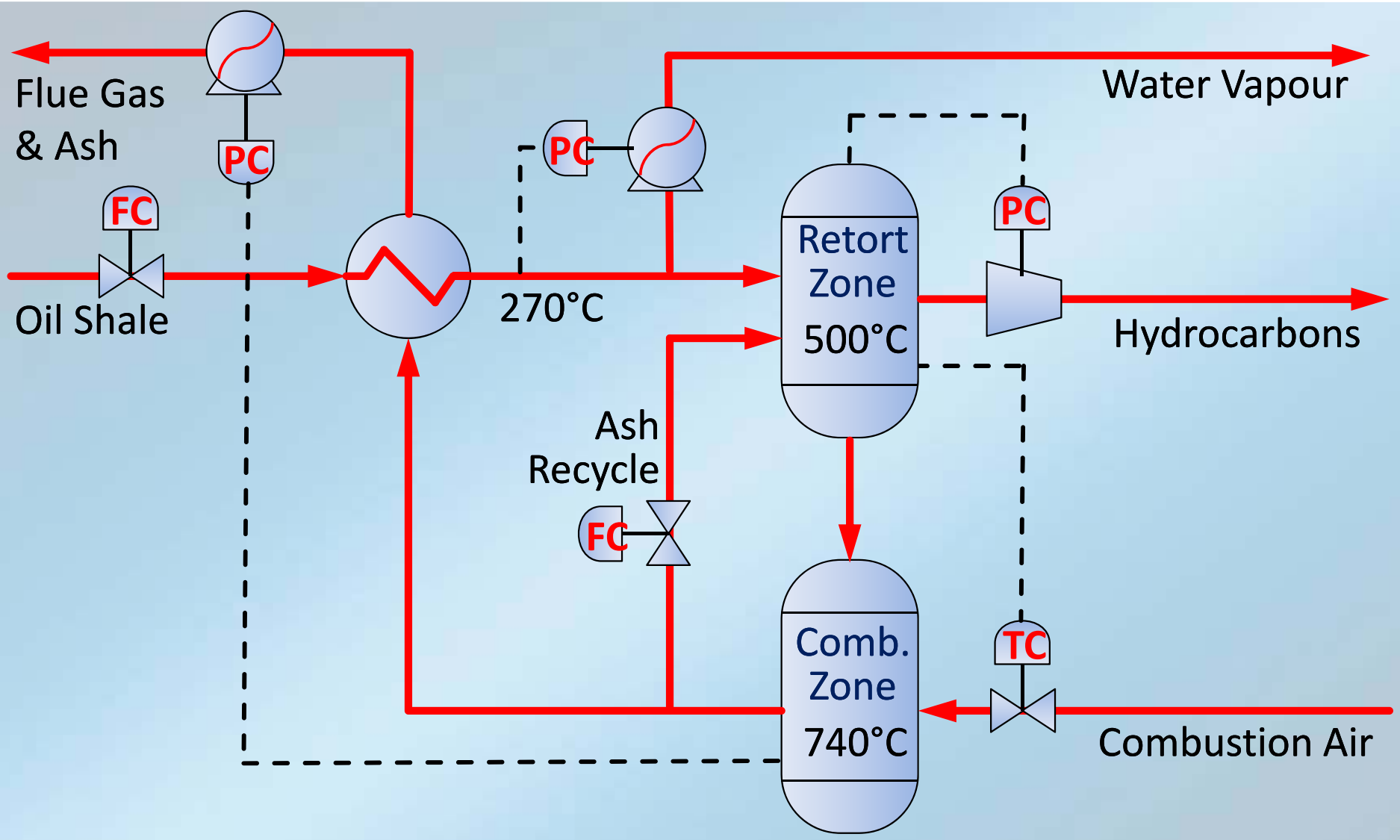
The ATP Processor Mechanical Arrangement



The ATP Processor Depicted as Discrete Process Vessels



The ATP Processor – Process Control

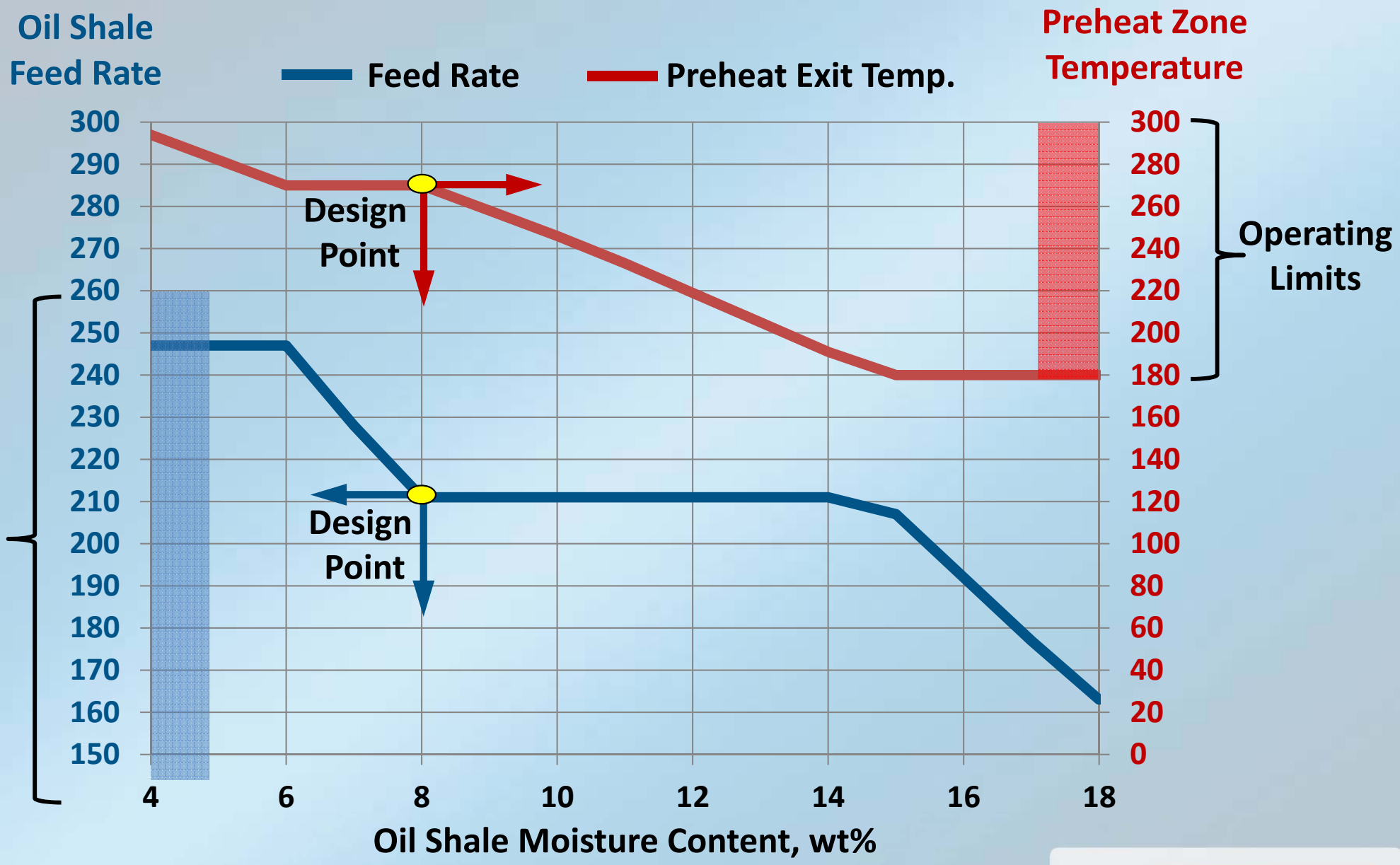


The ATP Processor - Process Control Boundaries

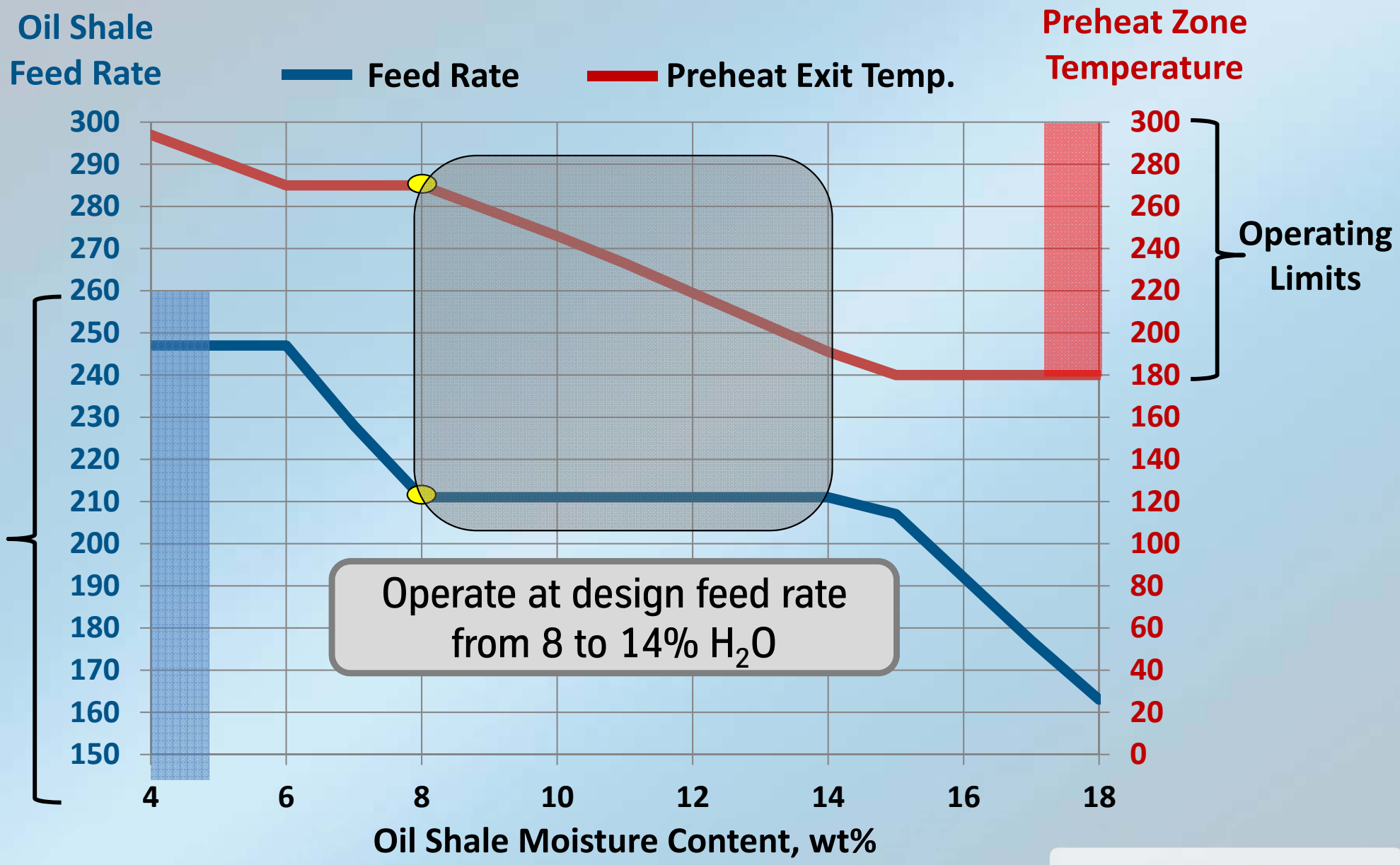
	Oil Shale Feed Rate, t/h	Preheat Temp, °C	Retort Temp, °C	Combustion Temp, °C
Low Limit	100	180	475	675
Normal Target	211	270	**505**	740
High Limit	265	300	550	760
Low Limit Reason	HC system turndown	Shale not dry before retort	Reaction kinetics	Combustion kinetics
High Limit Reason	Flow of solids through ATP	Premature pyrolysis	Excessive pyrolysis	Metallurgy

Retort temperature controlled +/- 5°C of target
Preheat & combustion temp. fluctuate within acceptable bounds
Oil shale rate maximized until system bottleneck approached

Example: Feed Moisture – Operation from 4 to 18% H_2O



Example: Feed Moisture Content



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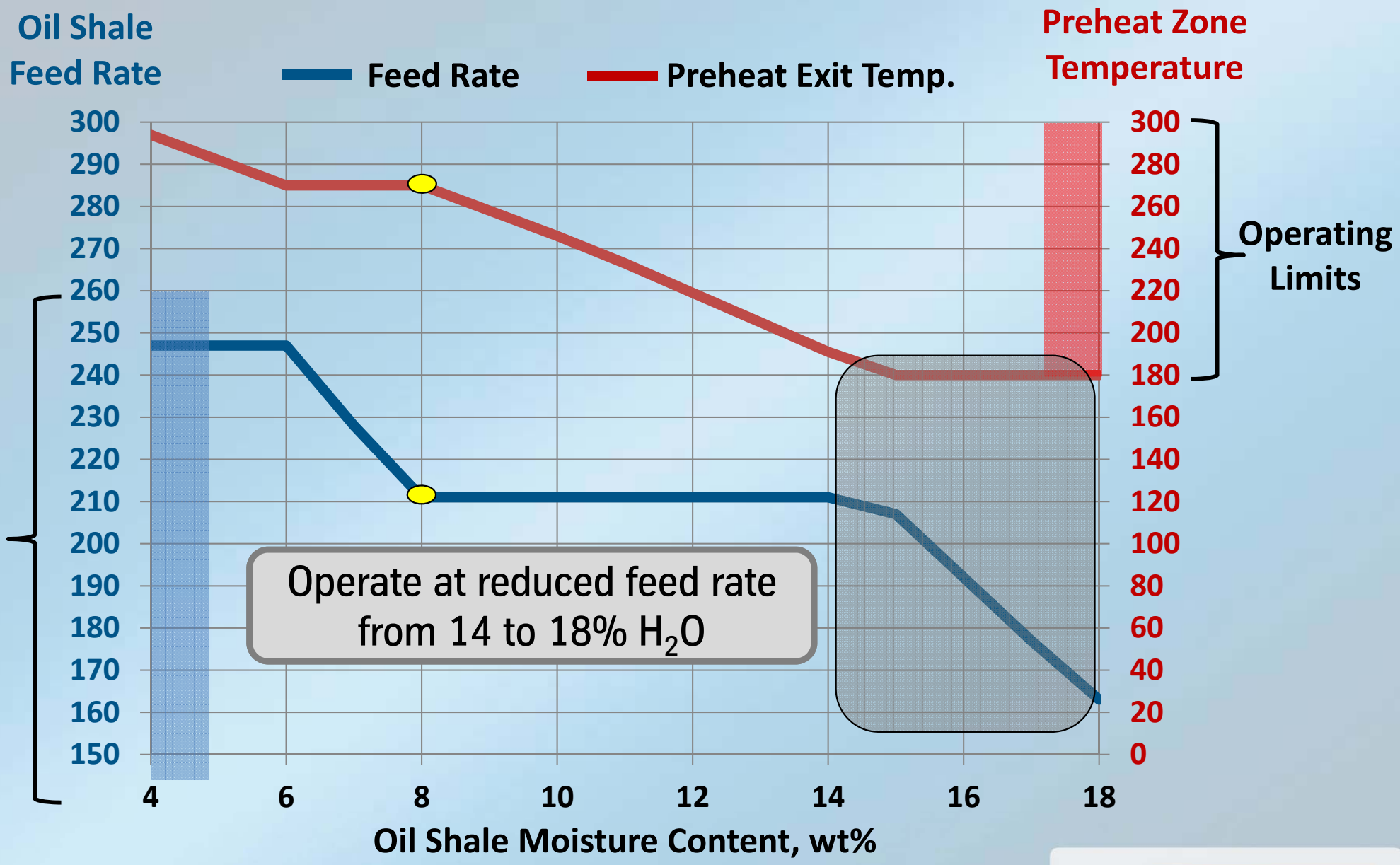

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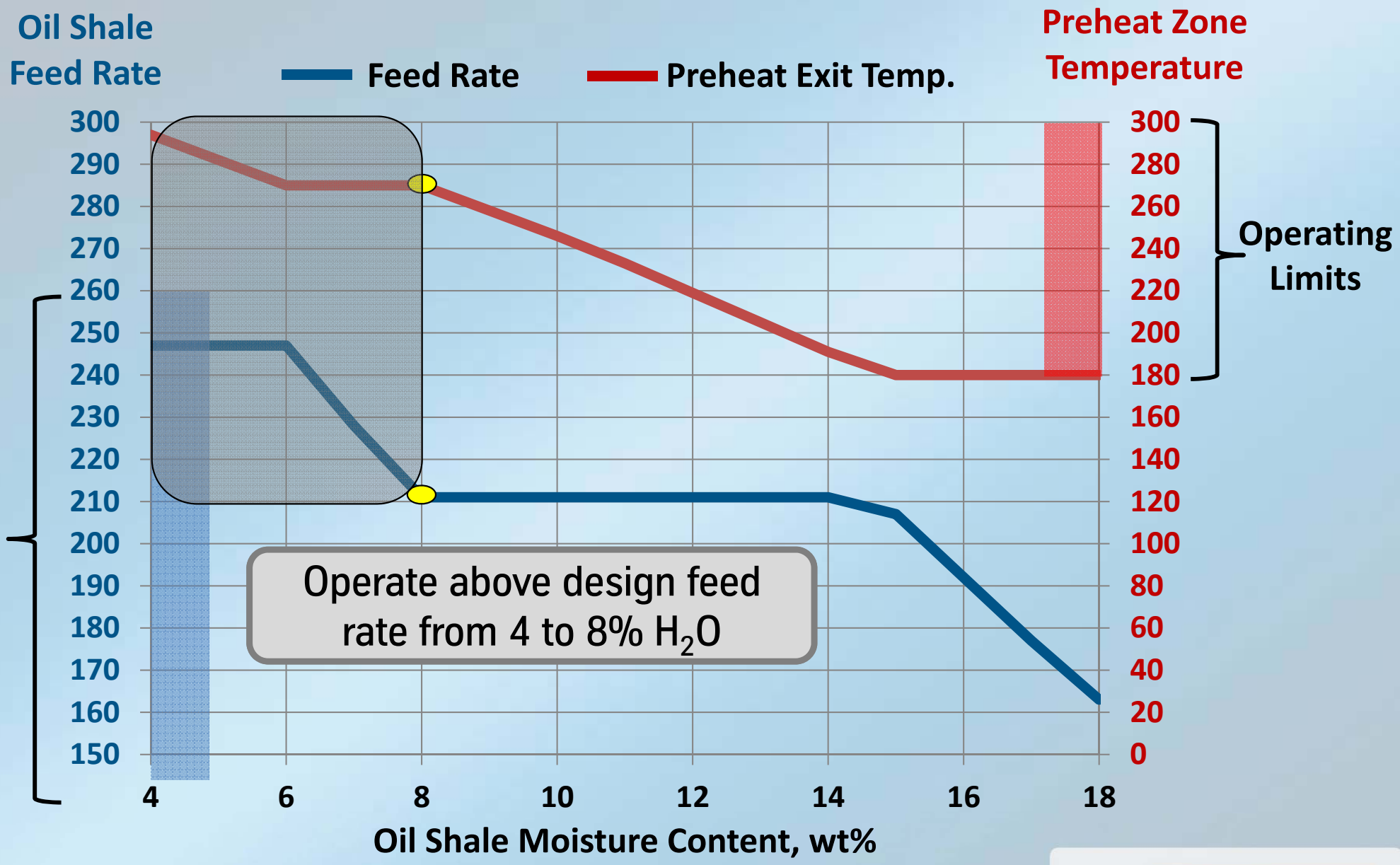
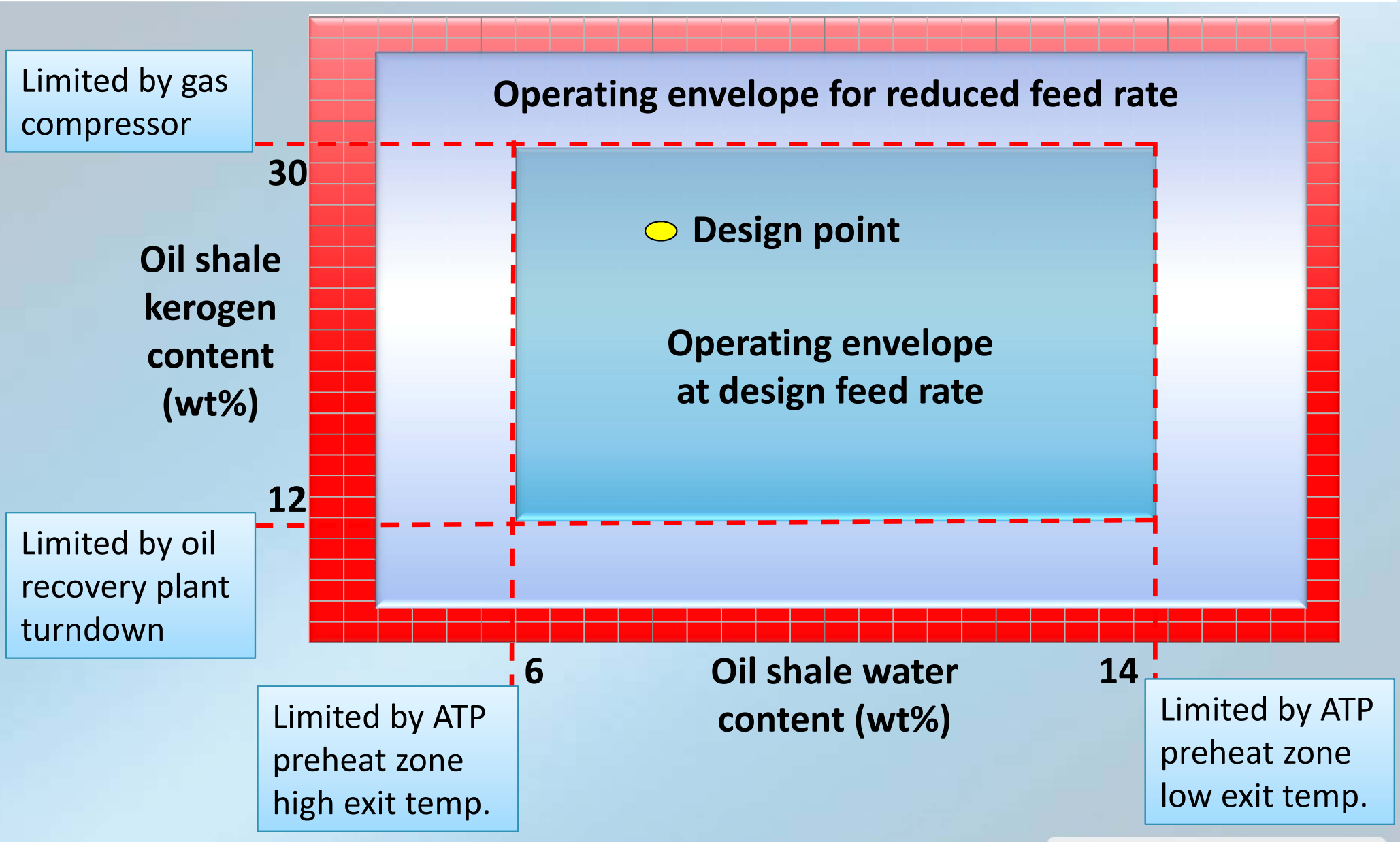
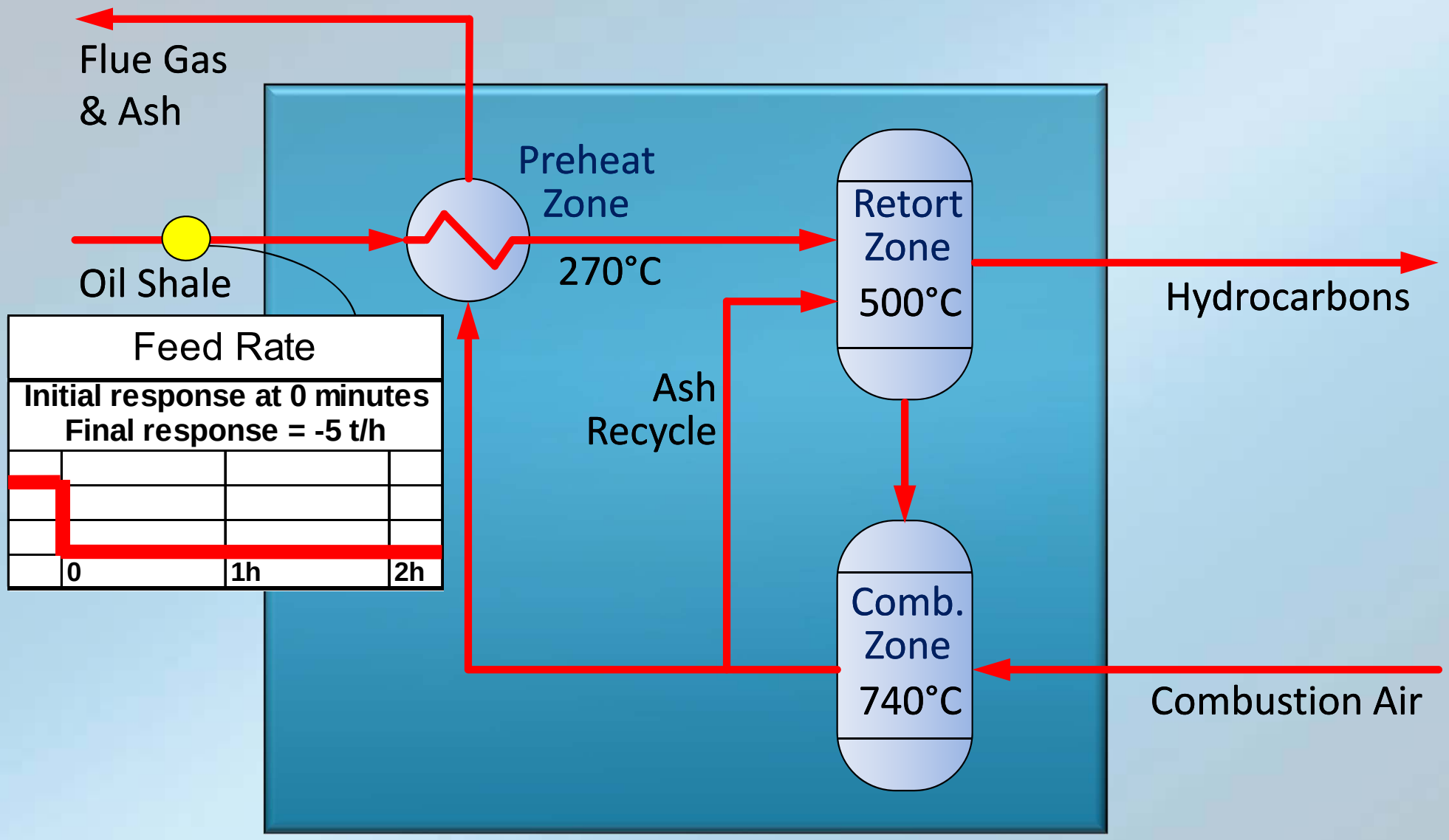


The ATP Processor - Wide Operating Envelope



Process Response to Feed Rate Change



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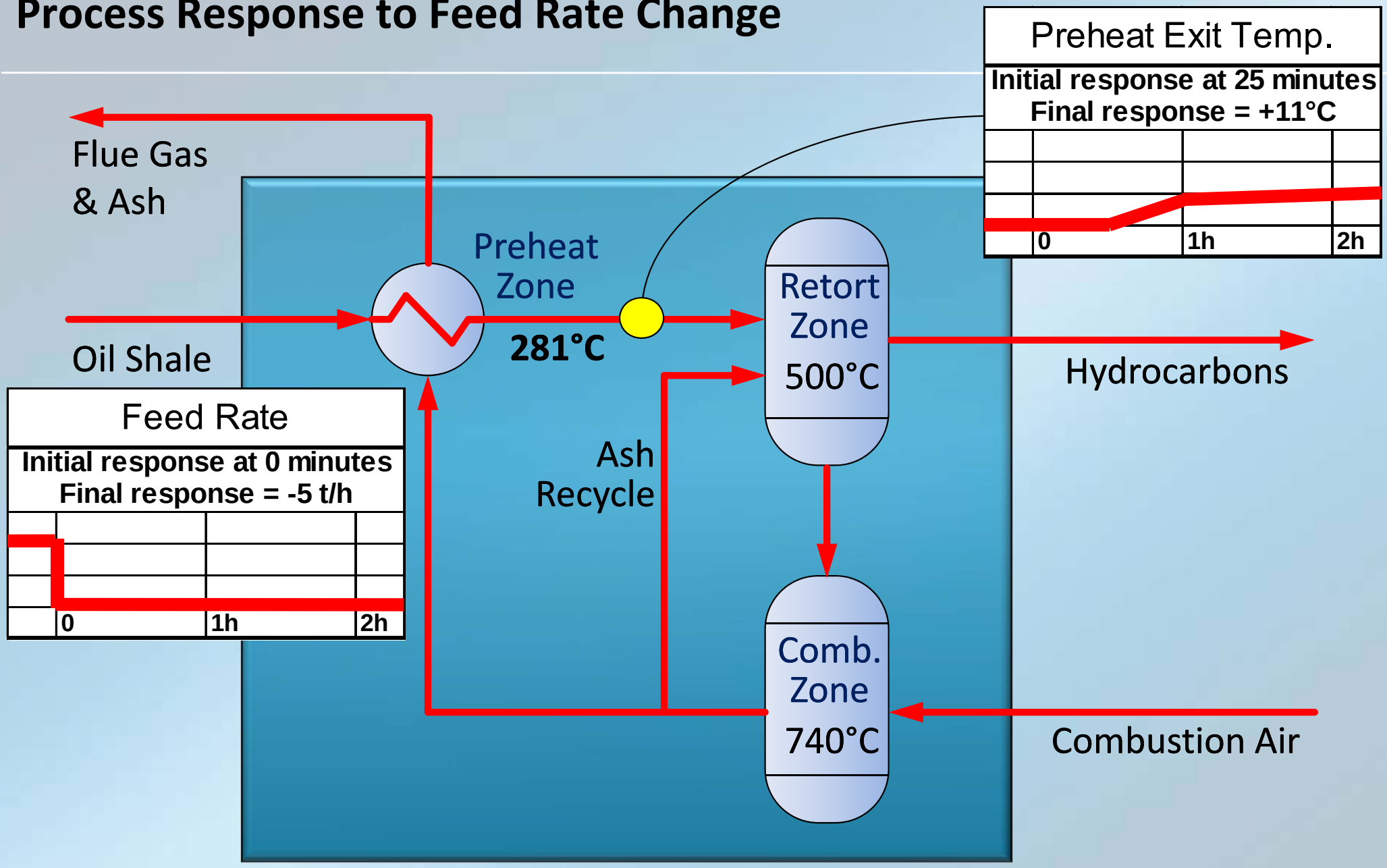

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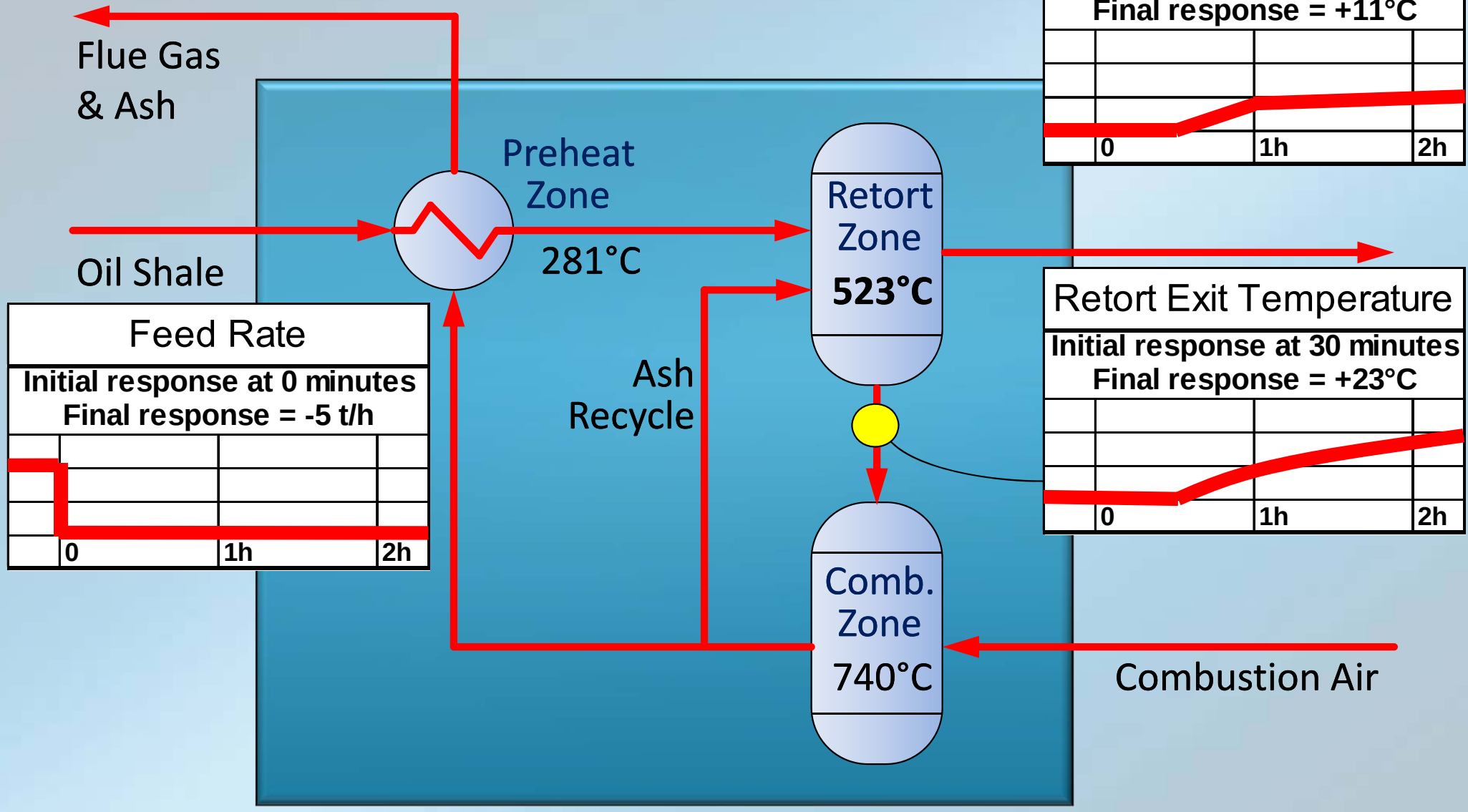


Feed Rate

Initial response at 0 minutes
Final response = -5 t/h

0		1h	2h

Preheat Exit Temp.

Initial response at 25 minutes
Final response = +11°C

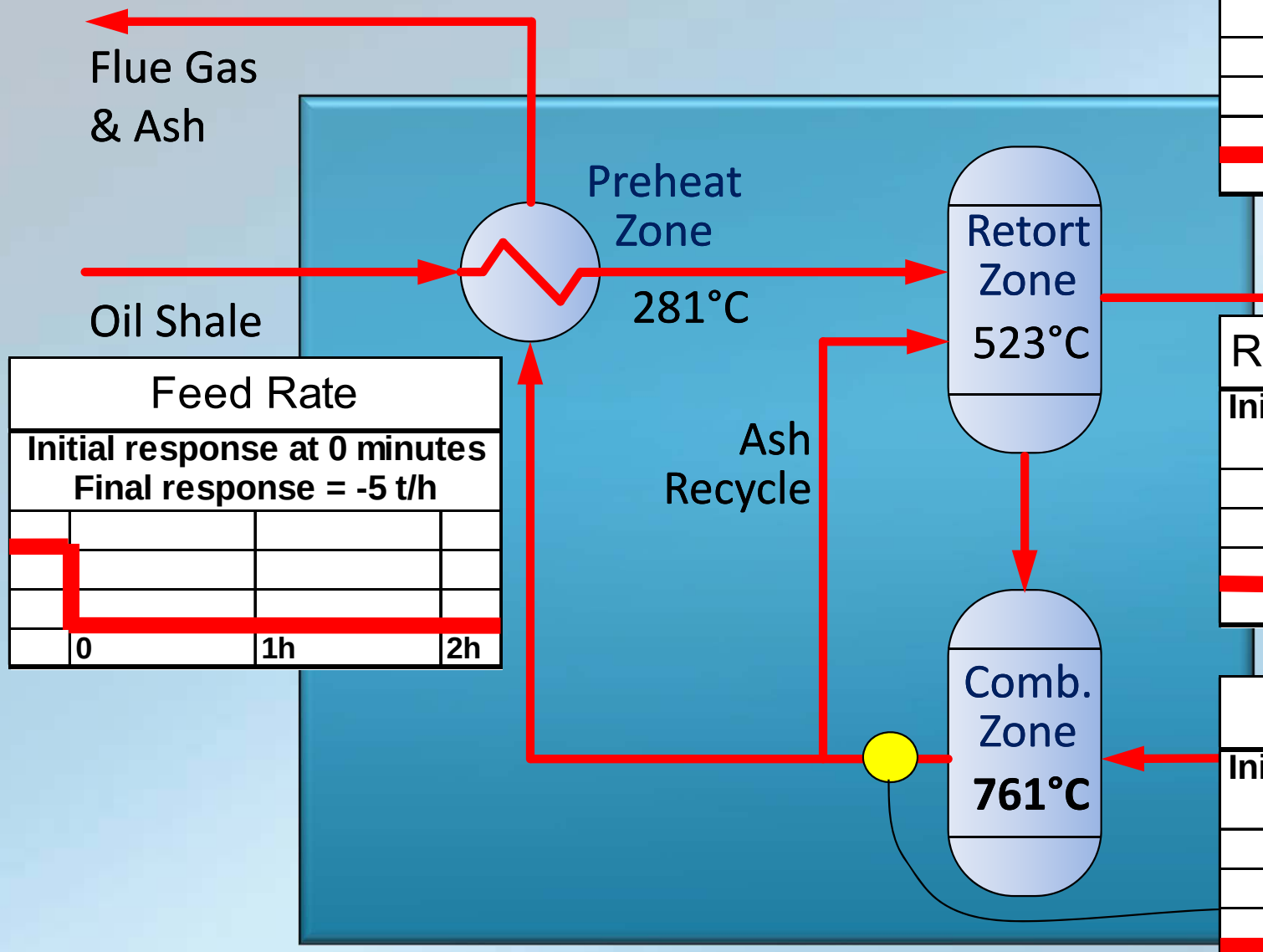
	0	1h	2h

Retort Exit Temperature

Initial response at 30 minutes
Final response = +23°C

	0	1h	2h

Process Response to Feed Rate Change



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Preheat Exit Temp.

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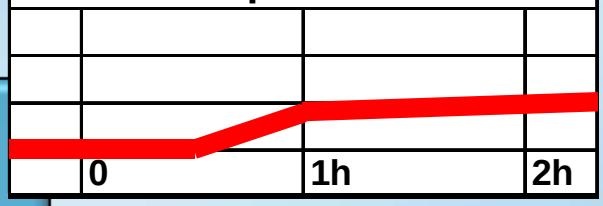
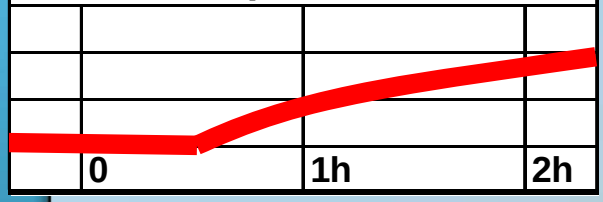


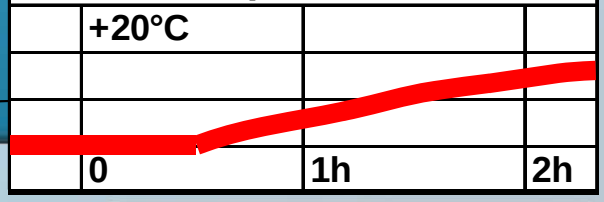
Retort Exit Temperature

Initial response at 30 minutes
Final response = +23°C

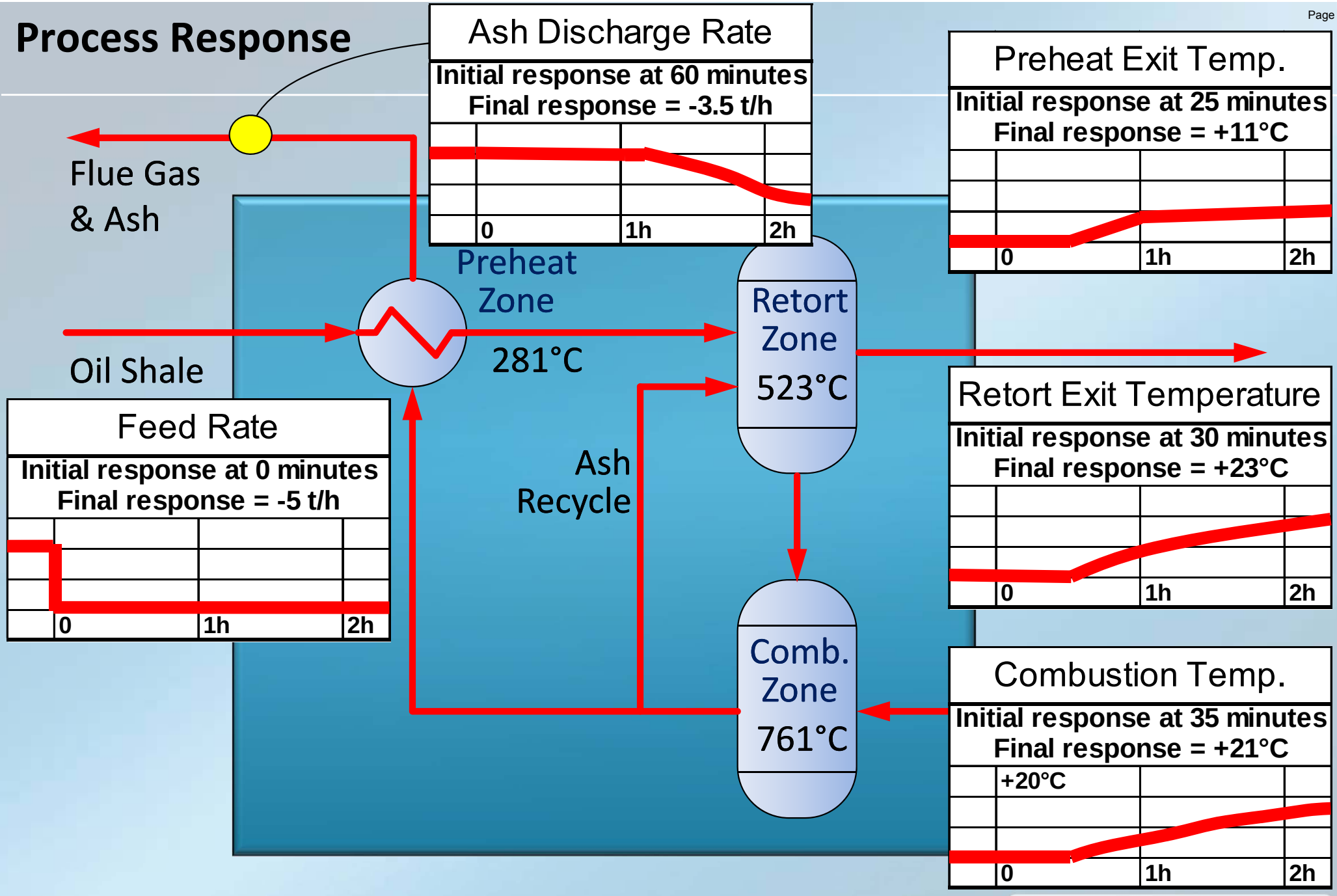


Combustion Temp.

Initial response at 35 minutes
Final response = +21°C



Process Response



Stable and Predictable Responses

Input Variable	Input Change	Preheat Exit Temperature	Retort Exit Temperature	Combustion Temperature	Ash Discharge Rate
ATP Oil Shale Feed Rate	5 t/h ↓	Initial response at 25 minutes Final response = +11°C	Initial response at 30 minutes Final response = +23°C	Initial response at 35 minutes Final response = +21°C	Initial response at 60 minutes Final response = -3.5 t/h
Coke Combustion Air Rate	2.5% ↑	Initial response at 10 minutes Final reponse = +14°C	Initial response at 15 minutes Final reponse = +28°C	Initial response at 1 minute Final reponse = +34°C	Initial response at 1 minute Final reponse = 0 t/h
Recycle Gate Position	40 t/h ↑	Initial response at 10 minutes Final response = -2°C	Initial response at 2 minutes Final response = +10°C	Initial response at 10 minutes Final response = -6°C	Initial response at 10 minutes Final response = 0 t/h
ATP Rotational Speed	0.3 rpm ↑	Initial response at 5 minutes Final response = +1°C	Initial response at 5 minutes Final response = +3°C	Initial response at 5 minutes Final response = +3°C	Initial response at 5 minutes Final response = 0 t/h

Concluding Remarks

Ore Feed Flexibility

- Ore variability will occur.
- ATP Systems are designed for specific oil shale, but are fully capable of handling a range of grade and moisture contents, giving operators increased flexibility in mine planning and plant operation.

Operational Stability

- ATP Processor is large rotary mineral processing unit which provides stable material handling and thermal processing.
- Predictable and controllable.
- Rotary machines are recognized for their tolerance to variations in feed and to transient operations.

Decoupling

- Important to decouple process units so that upsets do not propagate through multiple systems.

Questions?

谢谢 Thank You شكرا

Kiitos Vielen Dank Merci

Aitäh Спасибо

Definitions / Legend

ATP	Alberta Taciuk Process
bbl	Barrel of Oil (~159 Litres)
°C	Degrees Celsius
FC	Flow Control
HC	Hydrocarbons
LT0M	Litres of Oil Per Tonne Of Zero Moisture Ore
PC	Pressure Control
rpm	Rotations per Minute
SCO	Synthetic Crude Oil
t/h	Metric Tonnes per Hour
TC	Temperature Control
Temp.	Temperature
wt%	Weight Percent

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