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Presentation To:

MINES

From R&D to Commercial Plant: Scale-Up Challenges of the ATP Technology

Colorado School of Mines, 31th Oil Shale Symposium

UMATAC Industrial Processes
A company of ThyssenKrupp Polysius

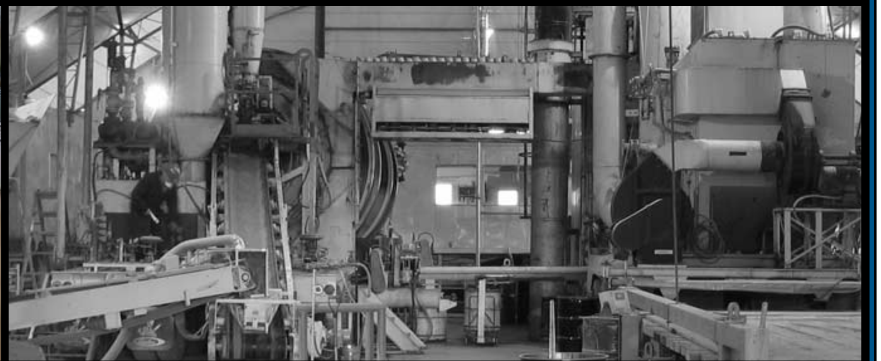
ThyssenKrupp

ThyssenKrupp Polysius

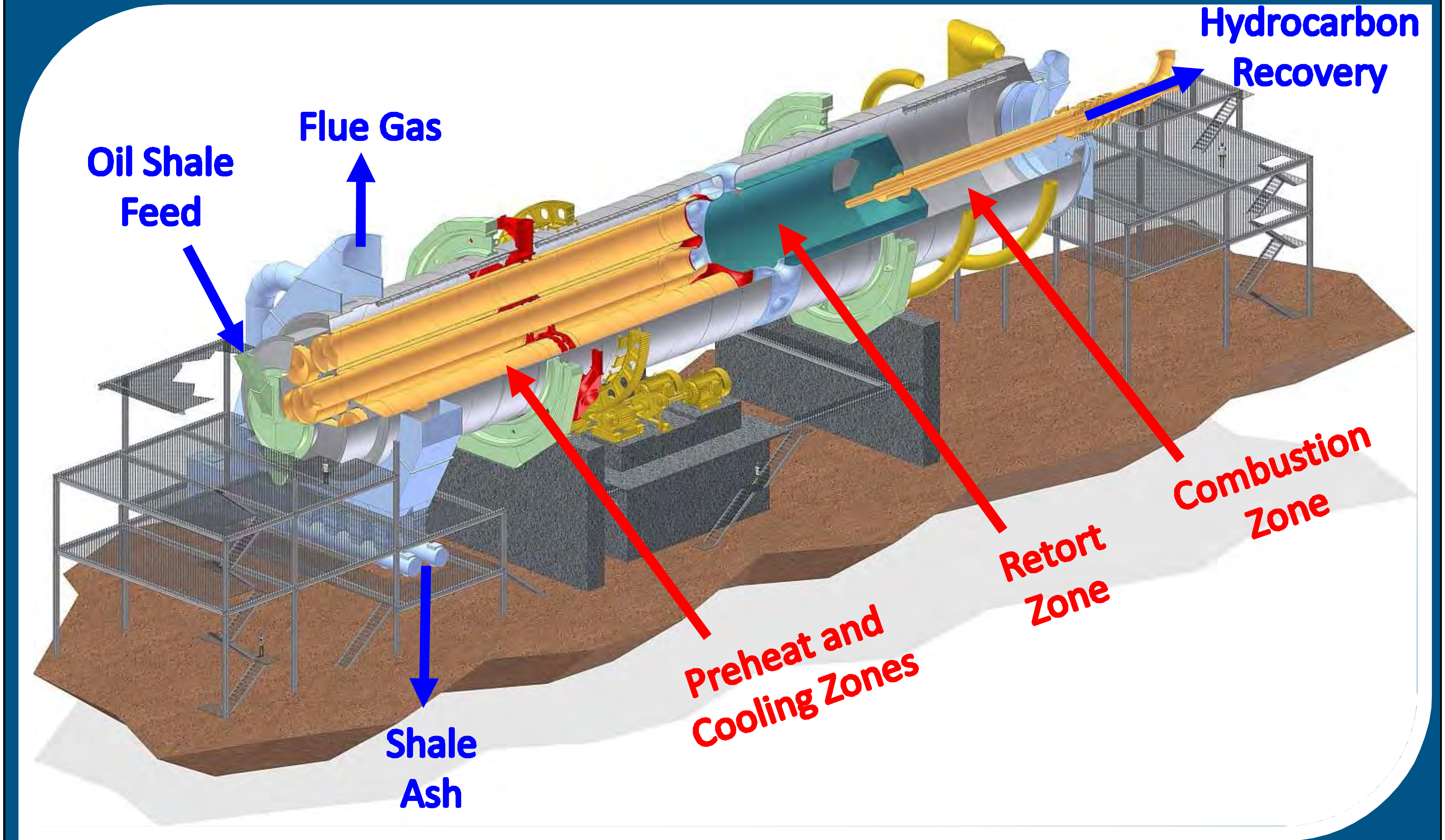
Agenda

- Introduction
- New competence center for oil shale technology
- Process scale-up to 12,000 t/d (500 t/h)
- Mechanical scale-up and implementation
- Questions

New Competence Centre for Oil Shale Technology

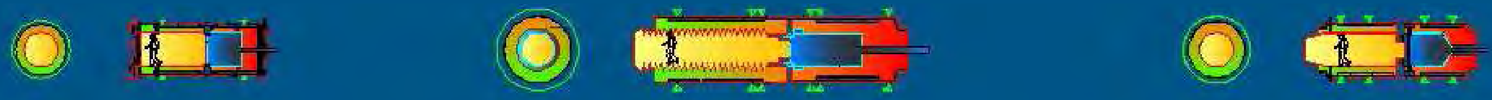


The ATP Processor

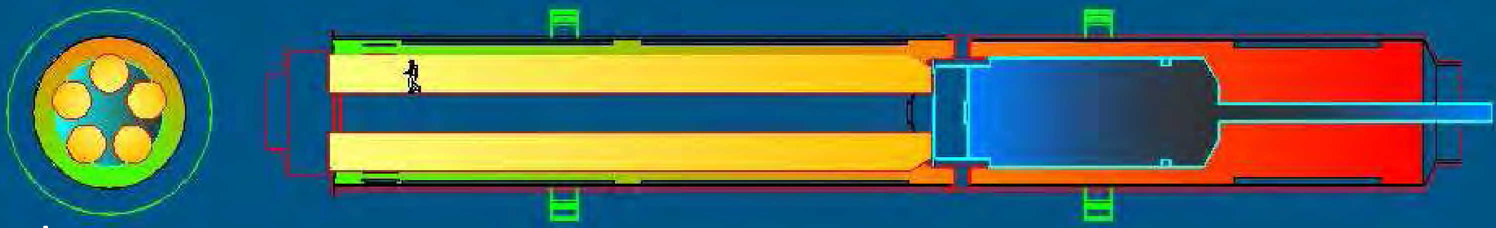


Scale-up History

1977, 1989, 1991



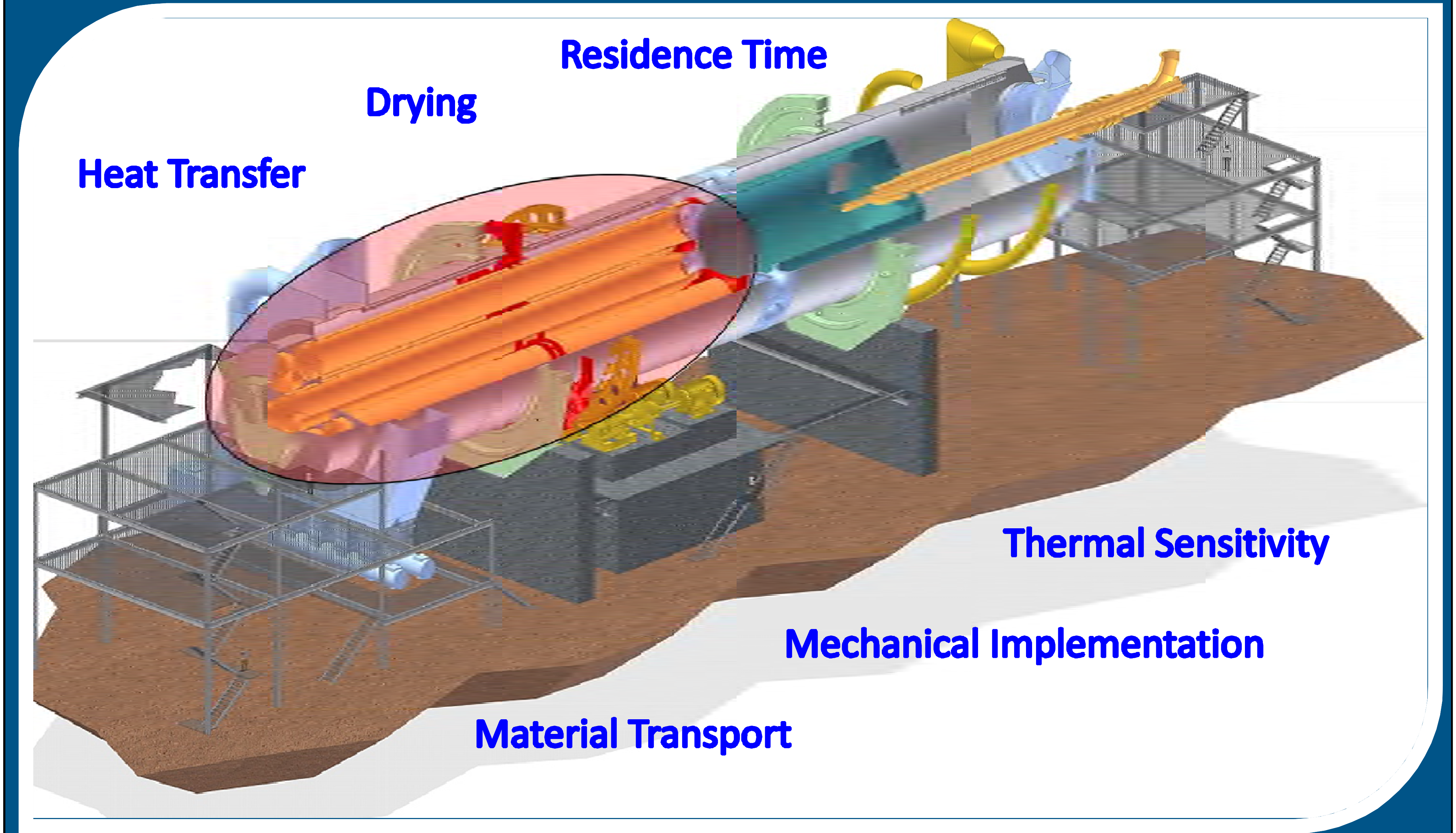
1997
211 t/h
8.3 m diameter



2006
230 t/h
8.3 m dia.

Next…
500 t/h
11.5 m

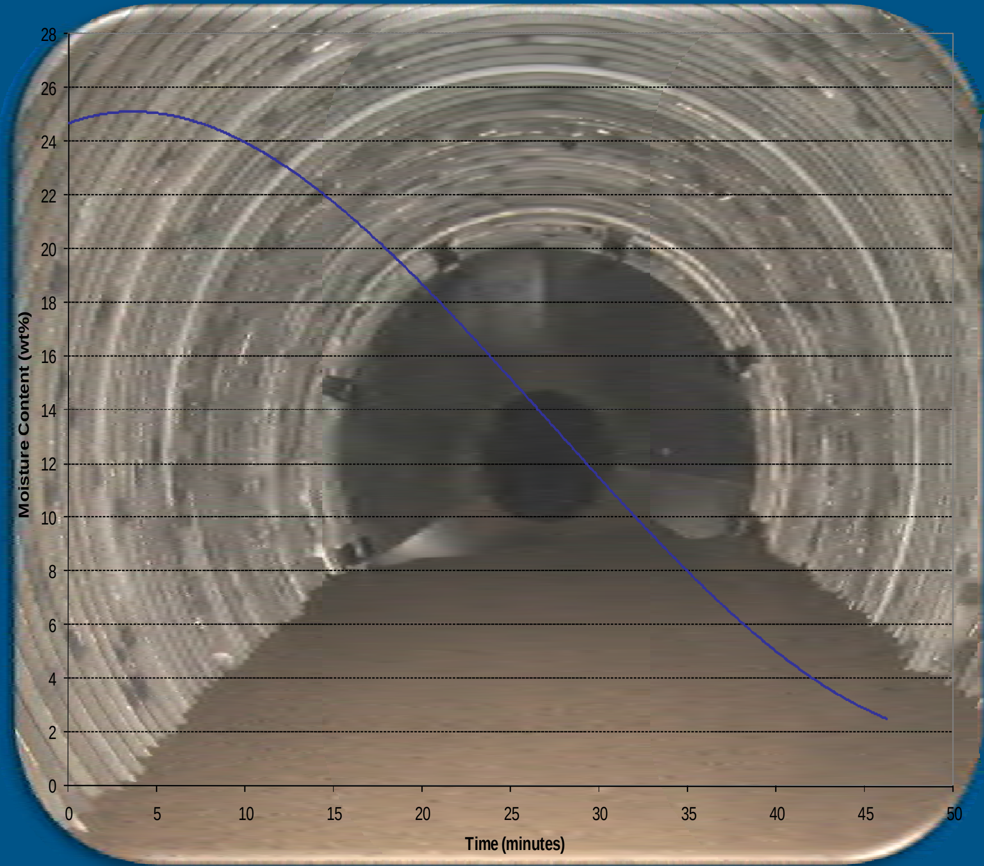
Preheat & Cooling Zones – Shell & Tube Heat Exchanger



Scale-up Parameters

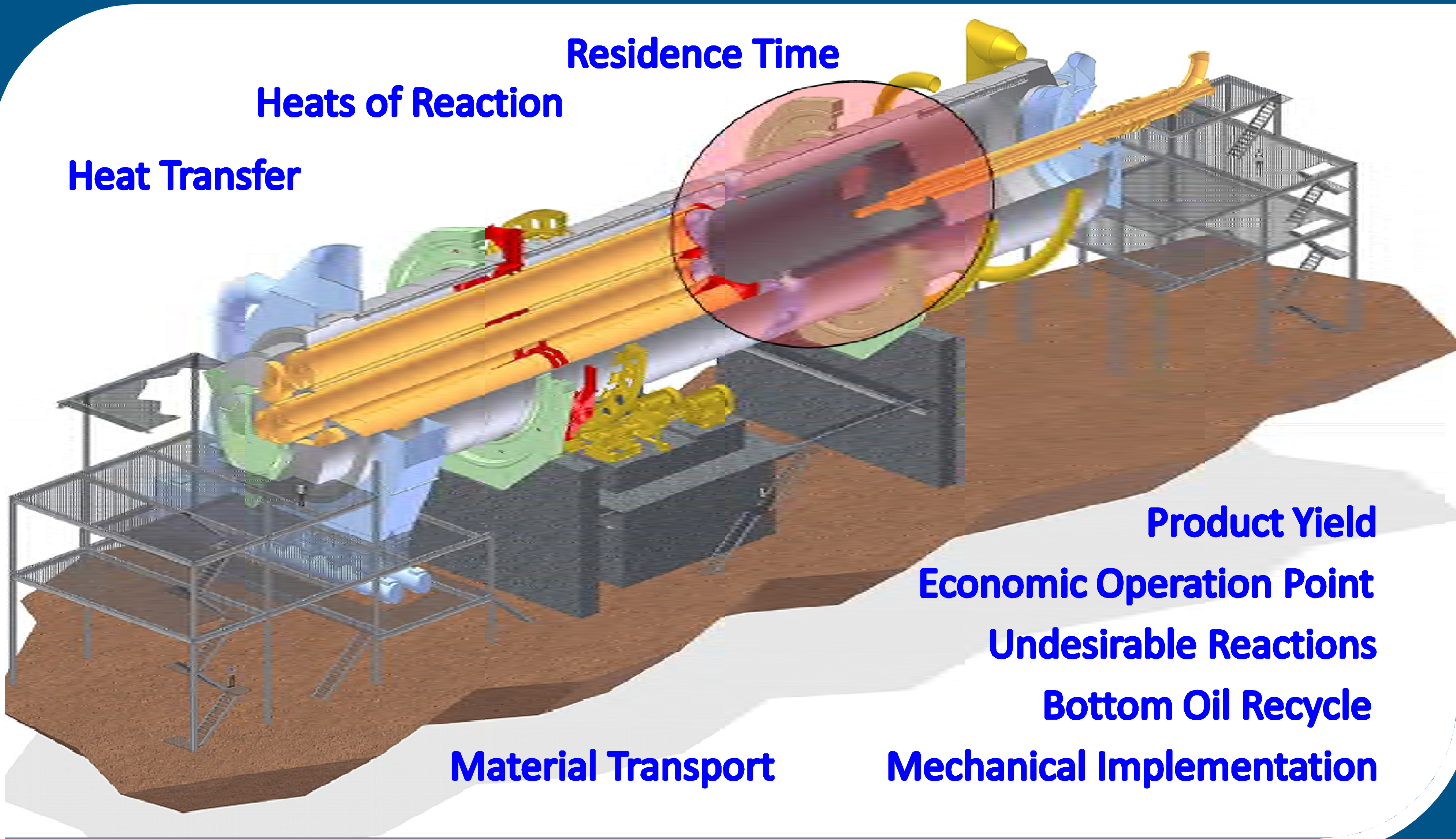
Preheat & Cooling Zones

- $Q = UA\Delta T$
- Heat transfer coefficients
  - U, h_i, h_o
- Enhanced surface area (*A*)
- Wall temperatures important
- Drying curve
- Solids transport mechanism and bed depth prediction



- Other factors (*rotation speed, % fill, radiation, convection, particle size*)

Retort Zone – Residence Time Driven Reaction Vessel

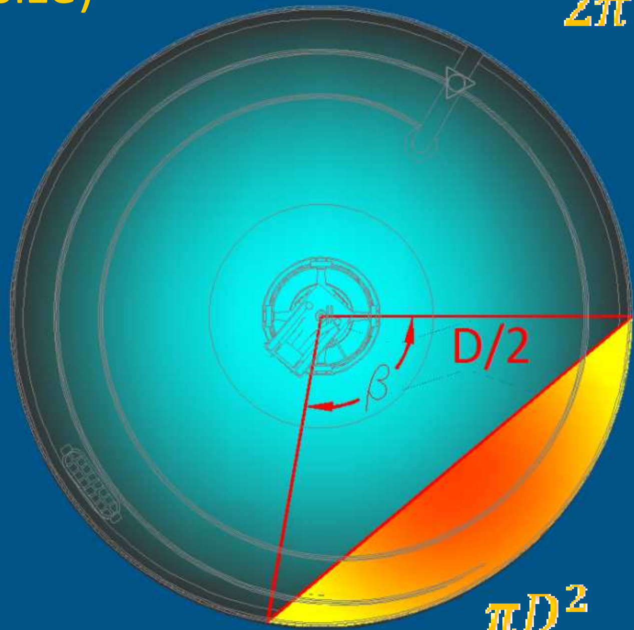


Scale-up Parameters

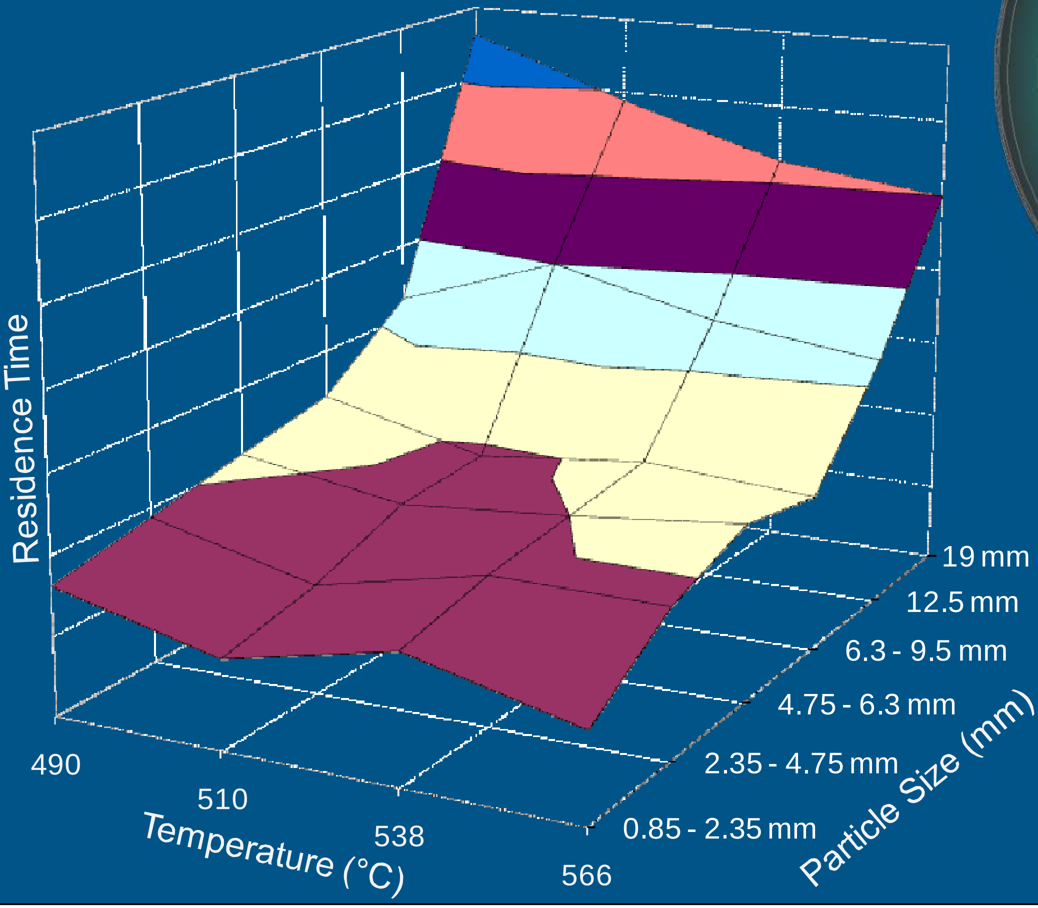
Retort Zone

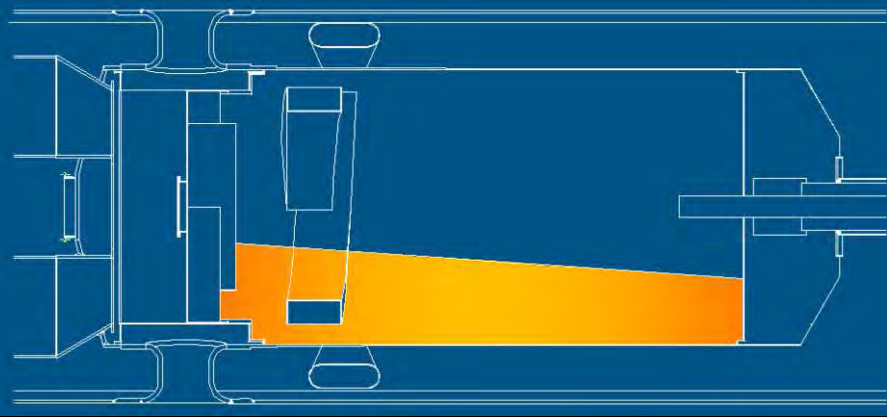
- Residence time (related to particle size)
- Complex heat & material balance
- Bed mixing must be considered
- Every ore is different!

$$\% Fill = \frac{100}{2\pi}(\beta - \sin(\beta))$$

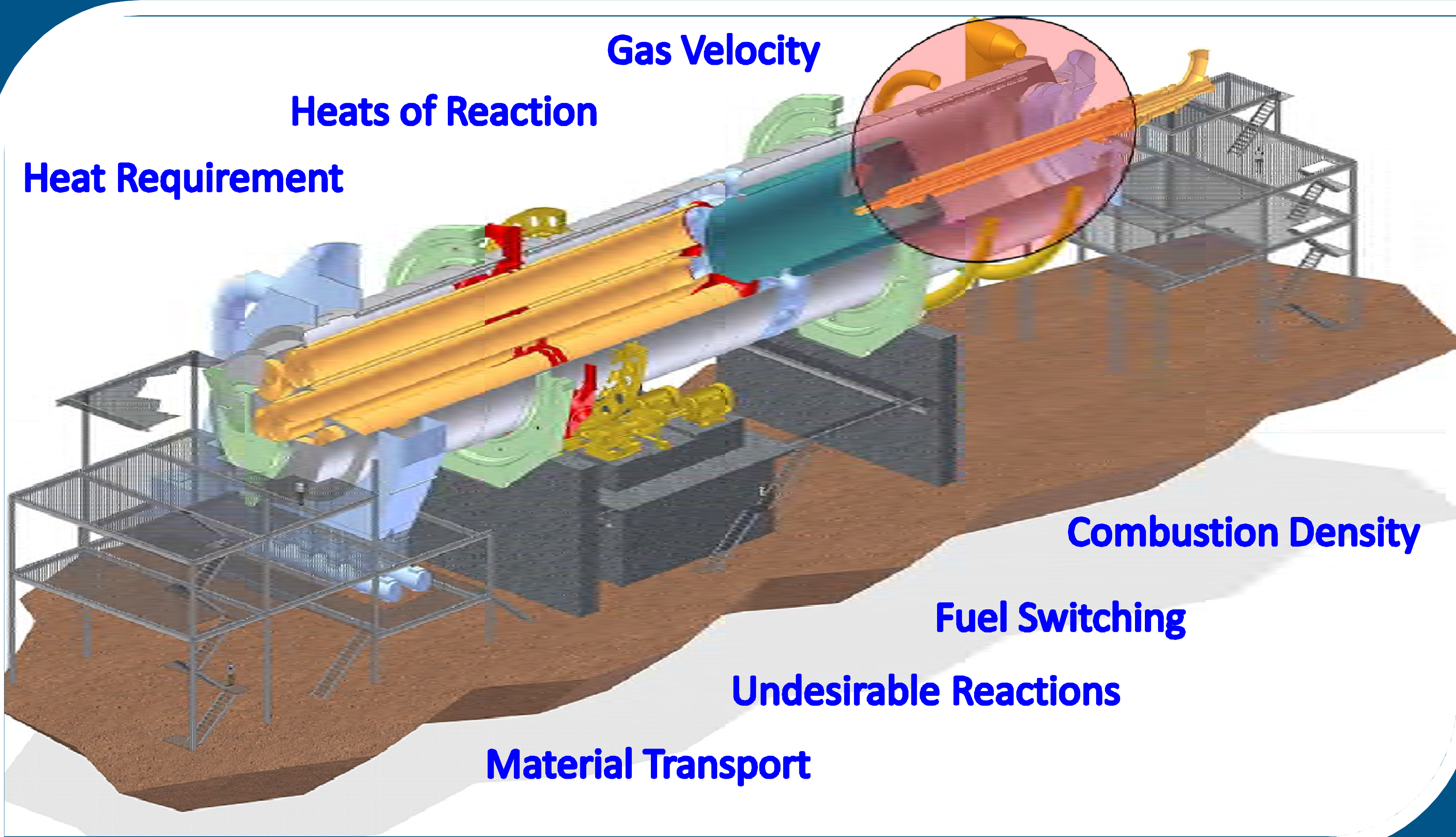


$$\tau = \frac{\pi D^2}{4} \cdot L \cdot \frac{\rho}{\dot{m}} \cdot \% Fill$$





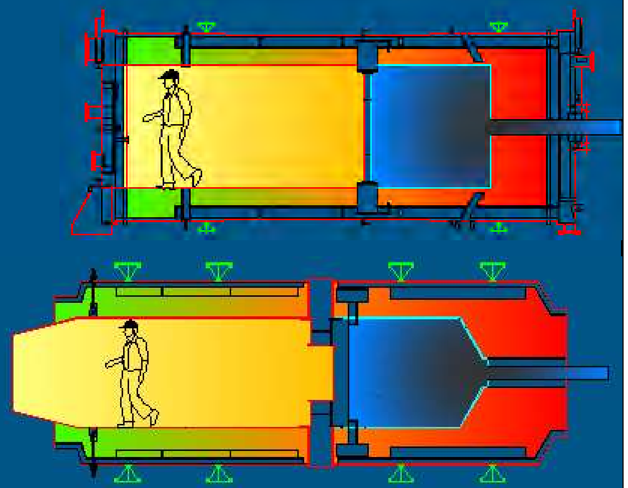
Combustion Zone – Similar to Fluid Bed Combustion



Scale-up Parameters

Combustion Zone

- Heat duty (*Q*) calculated.
- Volume calculated from combustion density (MW / m^3).
- Lifters designed to achieve target solids concentration in gas phase.
- Temperature influences CO generation and mineral decomposition.
- Mineral decomposition reactions are important (CO_2, ammonia).
- Mass transfer kinetics can be important (but not always).
- Combustion is disassociated from material transport.



Scale up from 120 to 6000 to 12000 t/d

75:1 Scale-up Proven at 6000 t/d (250 t/h)

- Process modelling tools are mature.
- Scale-up techniques worked.
- Mechanical design proven.
- Demonstration project completed.

Third Generation ATP Installed in China at 5500 t/d (230 t/h)

- Field machining of tyres proven.
- Reliability and operability improvements implemented.

2:1 Scale-up to 12,000 t/d (500 t/h):

- ATP & hydrotreating pilot tests complete.
- Feasibility study complete.
- Feed distribution & mixing in retort zone.
- Project implementation – large scale greenfield project including upgrading. and power generation plants.

Proven Polysius Technologies — World Class Partners

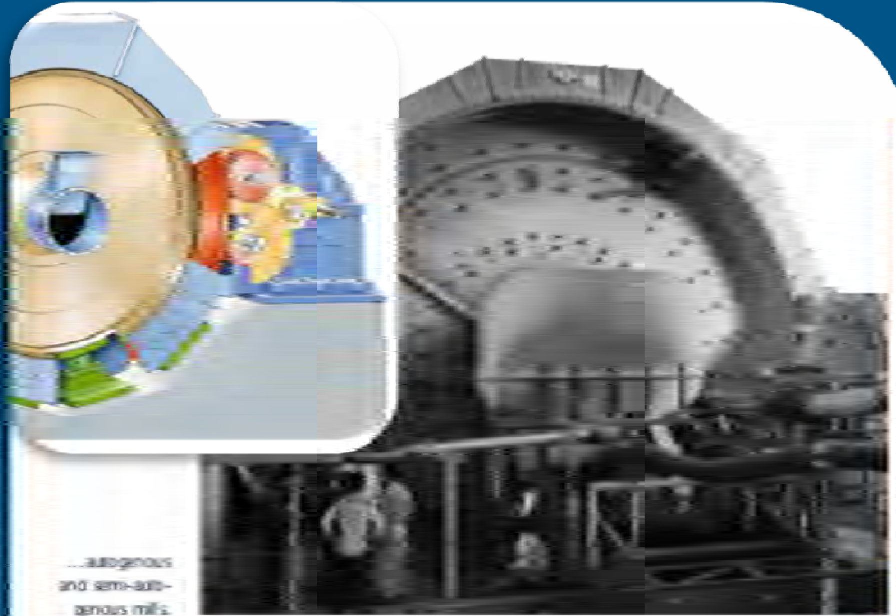
Proven Mechanical Systems for the 500 t/h ATP Processors:

- Slide shoe bearing support system (ATP is 5400 tonnes).
- Ring gear, Combiflex®, or ring motor drives up to 20 MW (ATP is 7 MW).
- Hundreds of kilns and mills built up to 10.4 m diameter (ATP is 11.5 m) and 120 m long (ATP is 76 m long).

Polysius has the proven machinery and experience.
UMATAC has the proven technology and process knowledge.
ThyssenKrupp Technologies has the team to deliver the project.

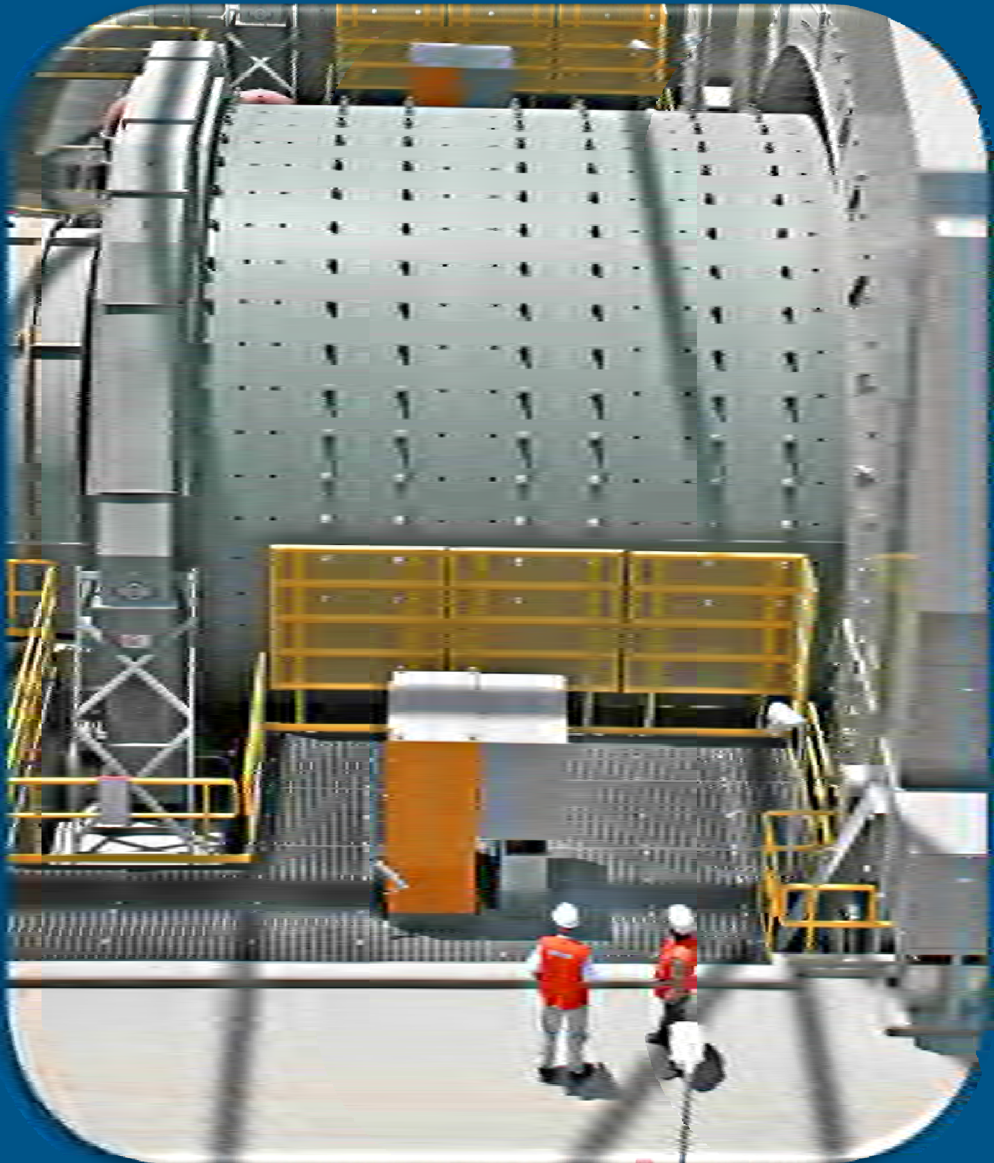
Proven Polysius Technologies

World Class Partners



...autogenous and semi-autogenous mills.

Di [m]	EGL [m]	P [kW]
8.0	3.9	3800
8.6	4.2	5000
9.2	4.5	6400
9.8	4.8	8400
10.4	5.1	9900
11.0	5.4	12100
11.6	5.7	14700
12.2	6.0	17600
12.8	6.4	21300
13.4	6.8	25400



谢谢 Thank You شكرا
Vielen Dank

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