Utilization of COG Excess to RhF Without A Gas Holder By An Automatic Control System For Mixing Combustion of COG & NG

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OUTLINE:

- **OVERVIEW**
- BACKGROUND
- UTILIZATION OF COG
- AUTOMATIC CONTROL SYSTEM
- ACHIEVEMENTS
- OPTIMIZING UTILIZATION OF COG
- CONCLUSIONS

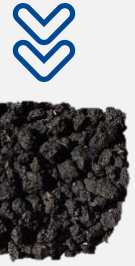
The clean COG produced by Coke Oven Plant is utilized by BFC, and the remaining 11,800 Nm^3/h has not been utilized and flared.

Coking Coal

Coal

Coke Oven

Crude Coke Oven Gas



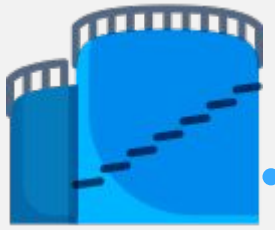
Coke

Chemical Recovery Plant

By product

- Crude Benzol 24,200 tpy
- Coal Tar 1,170 tpy
- Sulfure 6,600 tpy
- Amonium Sulfate 6,550 tpy

COG Holder

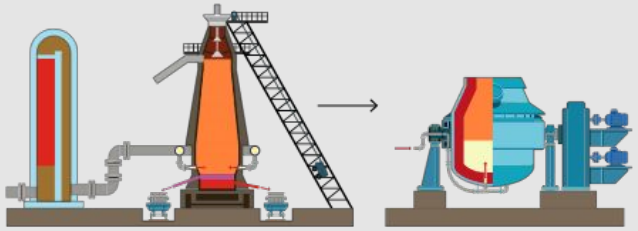


Clean COG
27,800 Nm^3/h

Excess COG

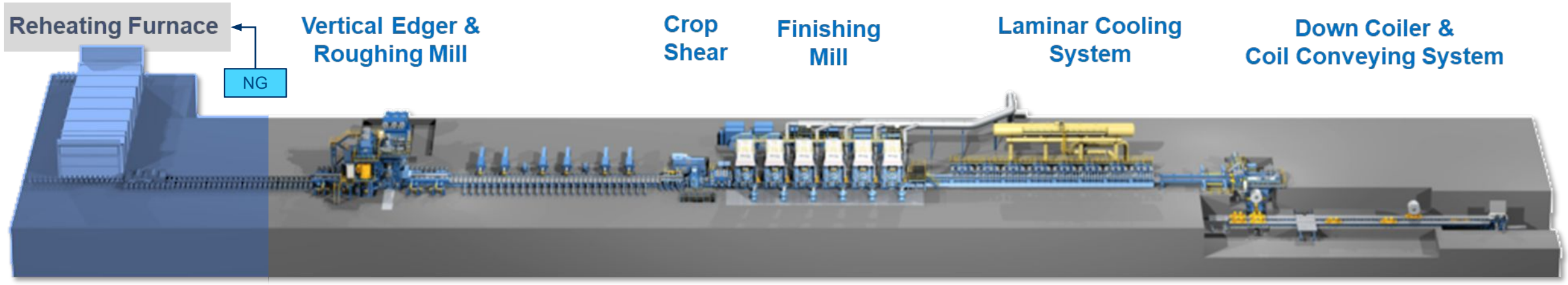
11,800 Nm^3/h

Blast Furnace Complex



16,000 Nm^3/h

Natural gas consumption in the Hot Strip Mill is the most significant energy used for the furnace combustion process



Product:

HOT ROLLED COIL

DIMENSION	
Thickness	: 1.4 - 25.0 mm
Width	: 600 - 2,000 mm
Coil Inner Diameter	: 760 mm
Coil Outer Diameter	: 2,000 mm max.
Coil Weight	: 30 Metric Ton max.

HOT ROLLED PLATE

DIMENSION	
Thickness	: 1.4mm-25mm
Width	: 300 - 2,000 mm
Length	: 1,250 - 12,500 mm
Pallet Weight	: 6 Metric Ton max.

HOT ROLLED SLITTED COIL

DIMENSION	
Thickness	: 1.4 mm - 8 mm
Width	: 128 - 990 mm
Coil Inner Diameter	: 760 mm
Coil Outer Diameter	: 2,000 mm max.
Coil Weight	: 30 Metric Ton max.

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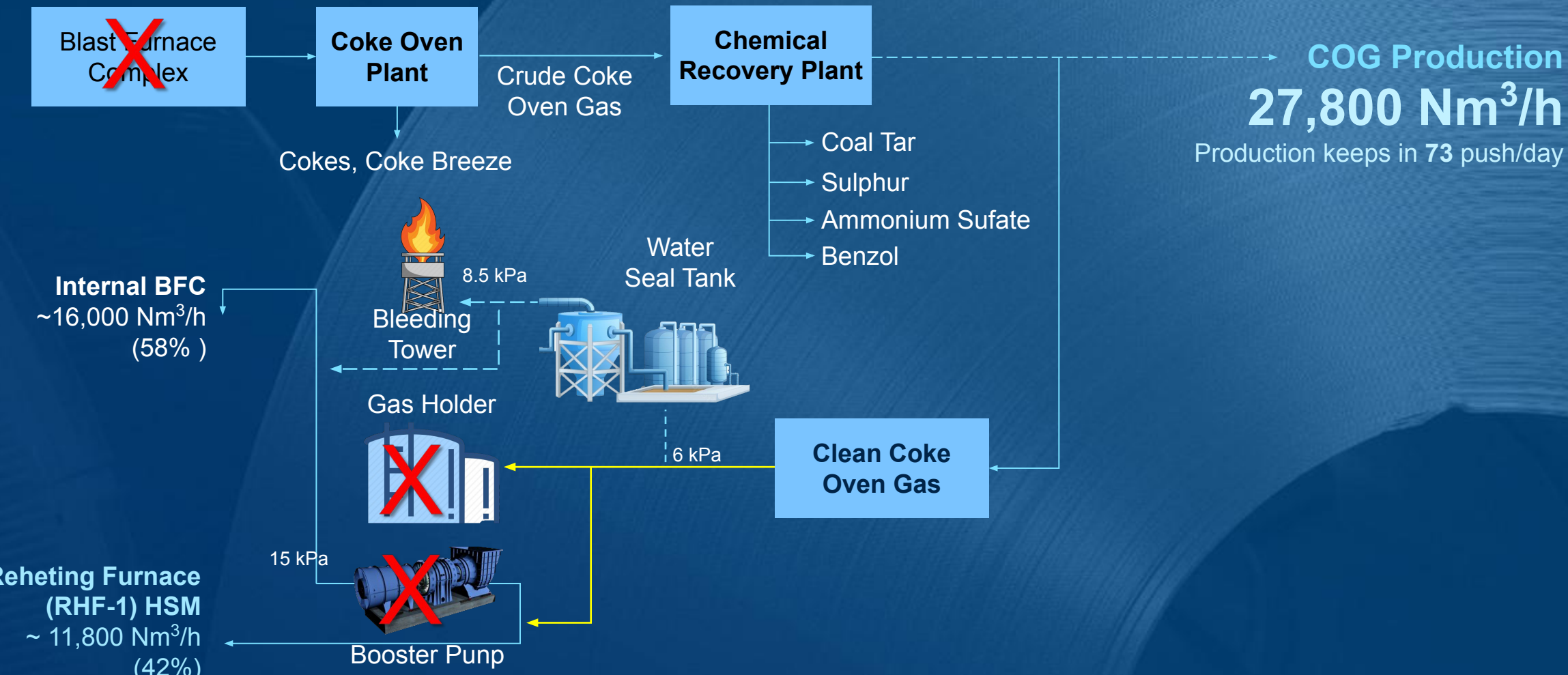
There is a COG excess of 11,800 Nm3/h, the remainder from internal BFC usage, which can be utilized for the Furnace-HSM

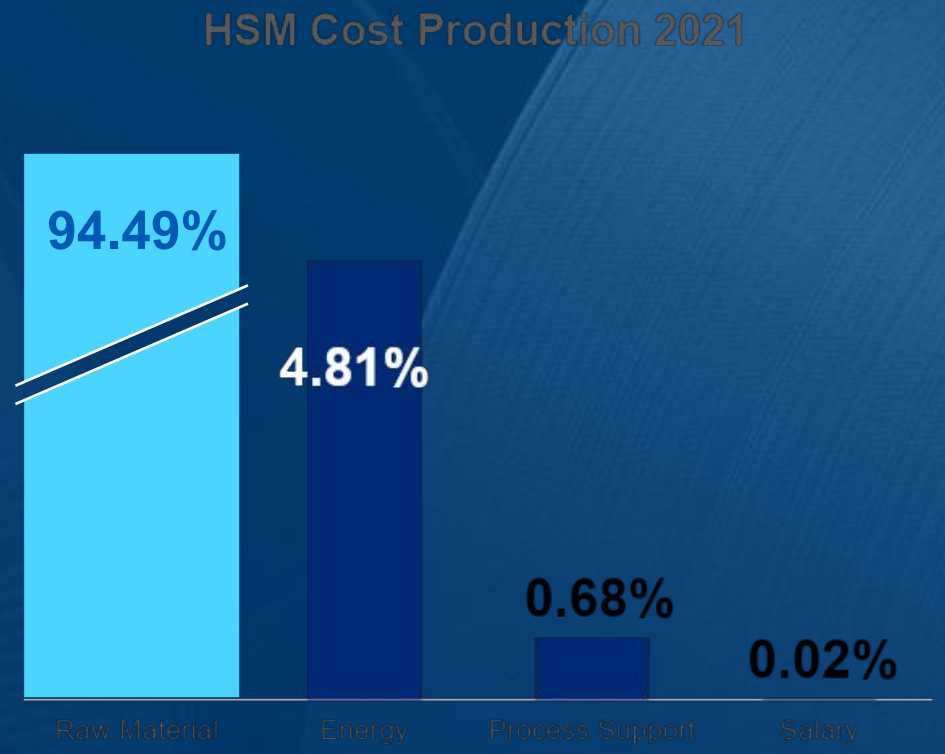
Coal Based Process (Project Design Blast Furnace Complex) :



Initiation of COG utilization for HSM based on energy costs in 2021 ranks second after raw materials in the production cost structure

Energy Cost

2nd *Largest of Cost Component*



Caloric value COG is relatively high

LHV Coke Oven Gas **4,000** kcal/Nm^3
LHV Natural Gas **8,400** kcal/Nm^3

1 Nm^3 COG **Substituted by** **0.47** Nm^3 NG
LHV NG 8,400 kCal/Nm^3

Fuel substitution RhF-1 HSM

The existing burner capacity design is sufficient to accommodate excess COG & NG

There is already done a COG feasibility study on existing RhF

Company initiatives in emission reduction

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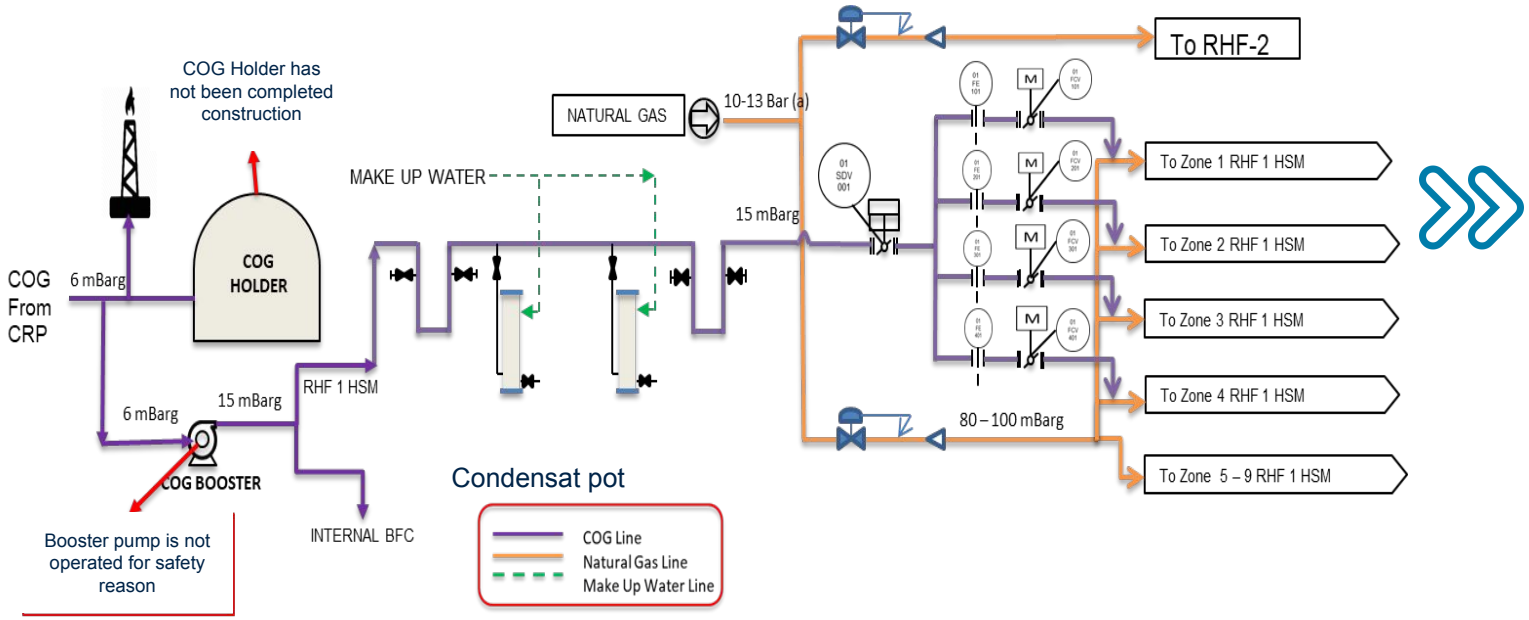
The concept design of COG utilization does not change the burner capacity, only the addition of pipelines and field instruments, as well as the installation of condensate pots to anticipate the carryover of coal tar



By installing a condensate pot, the fraction of viscous liquid in the pipe can be reduced.

No burner modifications are made in each zone, just adding a new gas pipeline and field instrumentation.

Design of mixing natural gas with COG in RhF HSM with only applied in zones 1, 2, 3 & 4.

The design of heat liberation required in each zone is different; the value is determined based on the heat requirement of each part of the slab to be processed

Heat Liberation Requirement RhF #1 HSM

Zone		Zone No	No. Of Burner	Design flowrate (Nm^3/h)	Max existing (Nm^3/h)	Heat Liberation (kcal/h)
Preheating	Top	1	10	3,858	2,315	20,138,760
	Bottom	2	8	4,585	2,751	23,933,700
Heating	Top	3	10	3,141	1,885	16,396,020
	Bottom	4	10	4,188	2,513	21,861,360
Soaking	Top	5	5	617	370	3,220,740
	Bottom	6	5	617	370	3,220,740
	Top	7	3	727	436	3,794,940
	Bottom	8	3	727	436	3,794,940
Soaking Discharge	Top Bottom	9	2	285	291	2,531,700
Total				18,745	11,367	98,892,900

Zone	Desain Flowrate Burner	Existing Flowrate NG (Max)	Project Design(COG+NG) (Nm^3/h)	
	(Nm^3/h)	(Nm^3/h)	COG	NG
1	4000	2315	3000	935
2	4000	2751	3000	1372
3	4000	1885	3000	505
4	4000	2513	3000	1133
5	620	370	-	370
6	620	370	-	370
7	720	436	-	436
8	720	436	-	436
9	500	291	-	291
TOTAL	**18.945**	**11.367**	12.000	5.849,8

Heat liberation needs of each zone are different, so it is necessary to calculate the mixed gas flow in each zone based on the calorific value.

Saving from reduction natural gas consumption are 5,517 Nm^3/h or 3,177,907 Nm^3/ month.

Assuming the natural gas price is 6 USD/MMBtu, total saving 114,288 MMBtu/Month equivalent to 640,000 USD/month.

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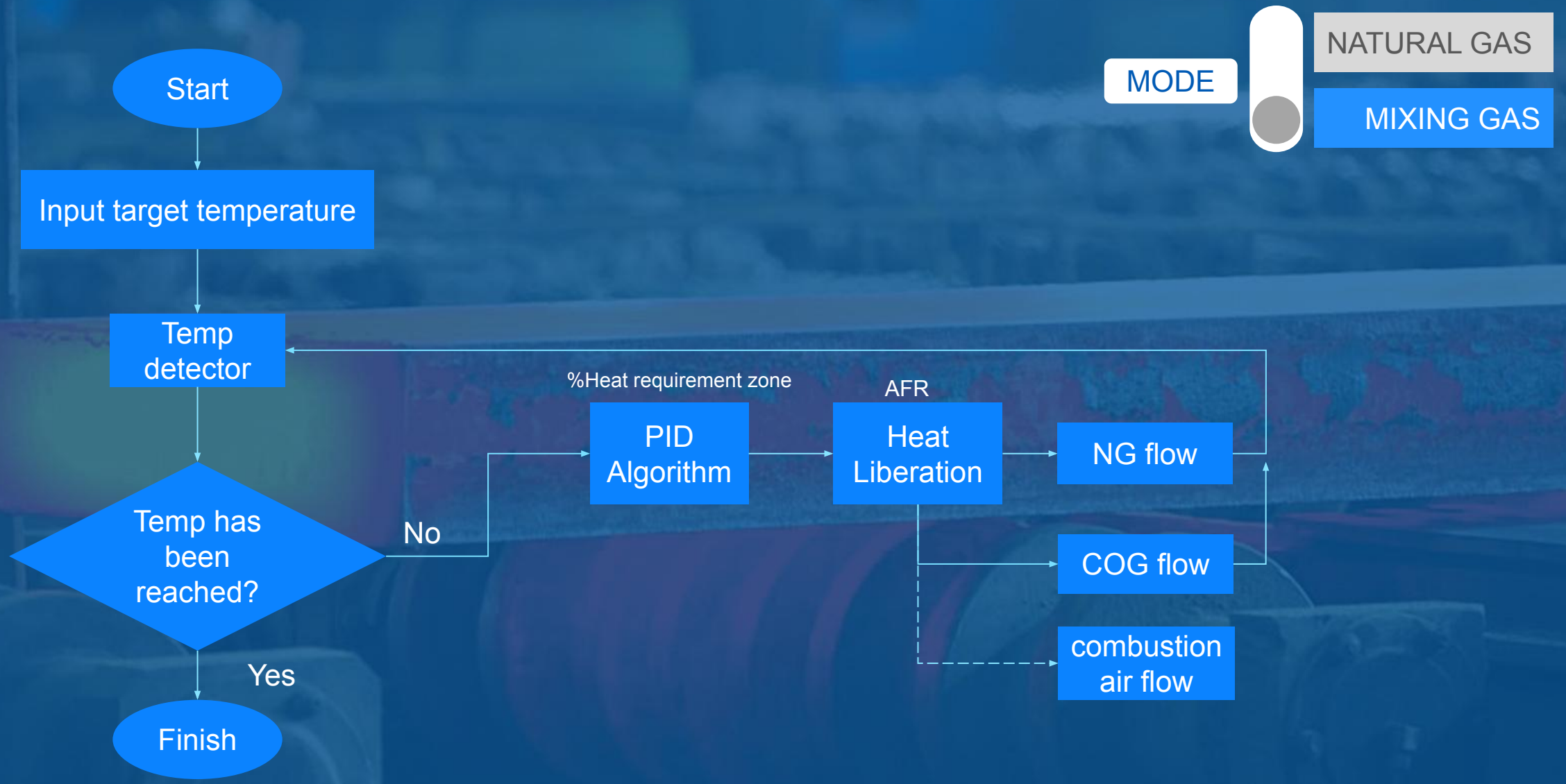
Control system in RHF using dual-mode fuel gas: full NG mode and mixing COG with NG at the line before burner with considering AFR value by an automatic



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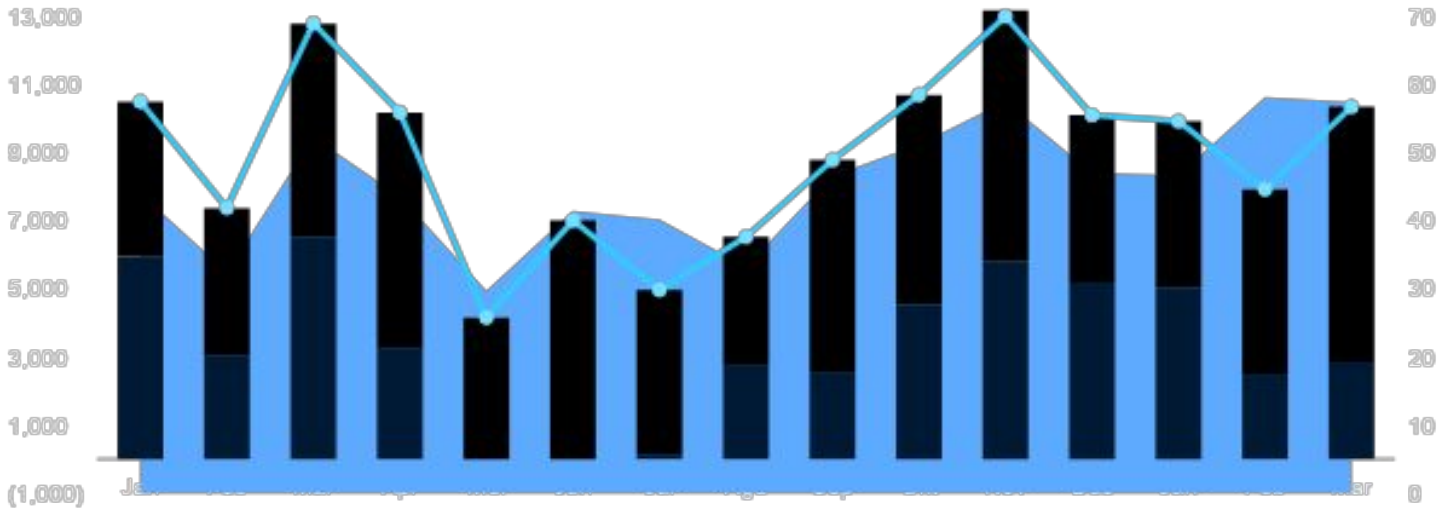
From the last performance, Krakatau Steel's achievement in utilizing excess COG to HSM without a Gas Holder obtained a total savings of 3.15 Mio USD.



May – July 2020	The COG distribution pipeline system is in trouble and under repair, and the Hot Strip Mill was undergoing an overhaul.

Historical Saving By RHF HSM	COG consumption 10^6 Ncm	NG Subtituted 10^6 Ncm	*Cost Saving 10^6 USD
2020	28.5	11.89	**2.5**
2021	7.5	0.31	**0.65**

The average Natural Gas saving achievement is **1.250.000 Nm^3/Month** or **32%** based on gas consumption in 2017.

The output temperature of the slab and the exit gas temperature in the Reheating Furnace when using natural gas are relatively lower when compared to COG.

Production yield remains achieved, **orders are maintained**, and it does **not affect product quality.**

Mixing NG and COG does not interfere with the processes that occur in the Hot Strip Mill either due to changes in the **combustion temperature** or a **shift in the flame due to the composition** and calorific value of different fuels.

**Natural Gas price calculation = 6 USD/MMBTU*

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Krakatau Steel's efforts in optimizing the utilization of COG in the future will build a Gas Holder and replace burner capacity.

Next Step

Short Term 2021

Preventive maintenance of the condensate pot. ✓

Coordination among work units. ✓

Optimum COG utilization: 4,600 Nm^3/h

(Average usage in 2020-2021)

✓ Already done

Medium Term 2024

Upgrading burner capacity & piping zone 1 & 2 from 3,000 Nm^3/h to 3500 Nm^3/h.

Target COG utilization: 7,000 Nm^3/h

Long Term 2026

Build the COG Holder and install the Booster Pump.

Burner and pipe replacement for 100% COG and 100% natural gas modes.

Target COG utilization: 12,000 Nm^3/h

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There are five conclusions from the implementation of COG utilization

Energy cost reduction by using **mixed gas mode** in Reheating Furnace can substitute natural gas to achieve savings of

32% or

3.15 Mill USD.

HSM Productivity remains optimal, the utilization of COG and automation can optimize energy efficiency to run HSM production.

Production performance of Hot Strip Mill::

- **Operation yield remains achieved.**
- **Orders are maintained.**
- **Not affect the quality of the product.**

Hydrogen content of more than 50 %, makes **COG more environmentally friendly,** an initiative to reduce emissions of COG consumption in RhF HSM by

32,550 kTon/year.

The utilization of **COG** will be more optimal if a **Gas Holder is operated, and by changing the burner to 100% COG mode, we will get more efficient and keep the environment.**

Emission factor COG : **0,65 kgCO_2 /Nm^3**
Emission factor Natural Gas : **2,29 kgCO_2 /Nm^3**

THANK YOU

If you have further questions, please send them to my contact via email at:
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