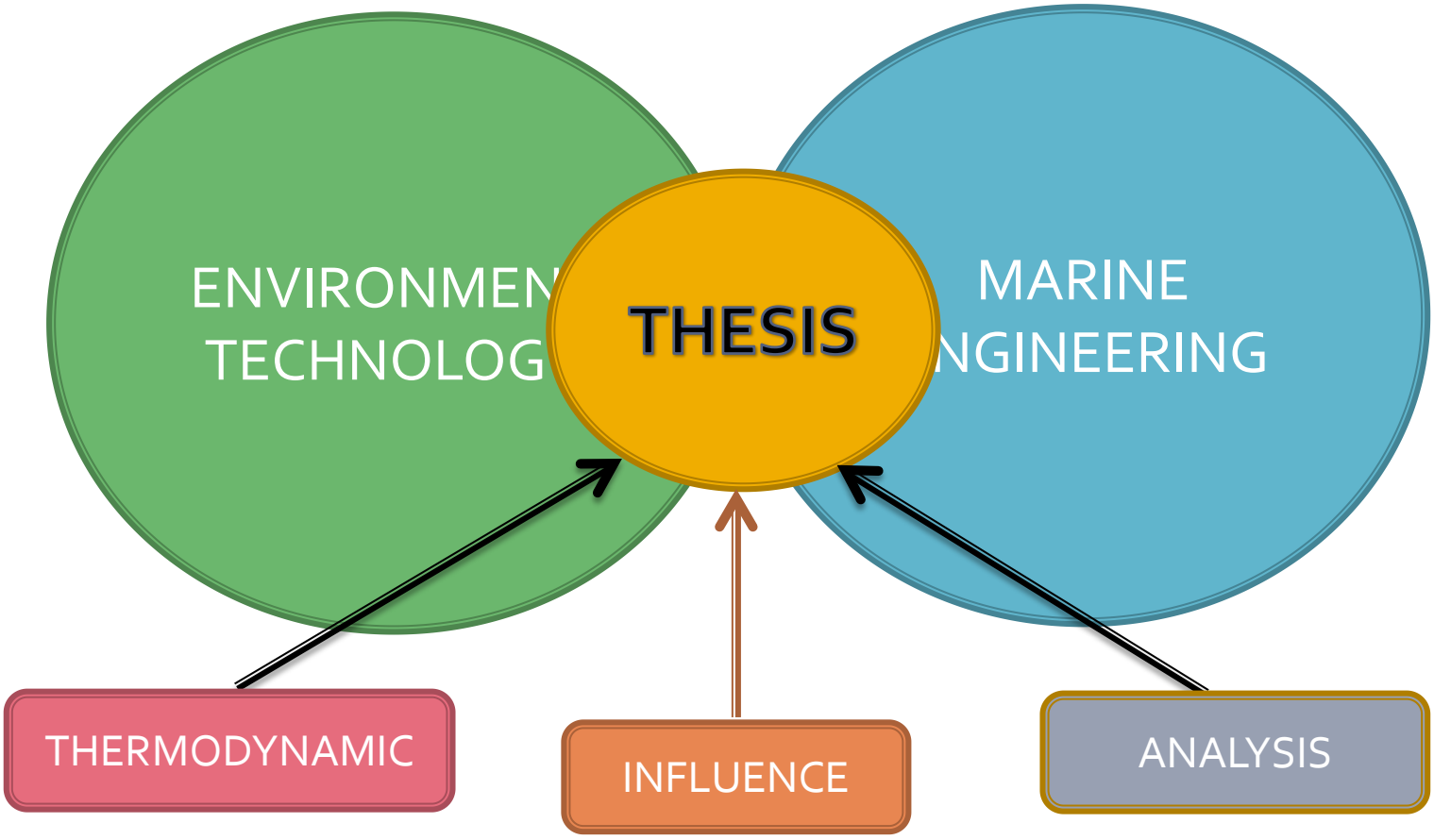
Bachelor Thesis Presentation

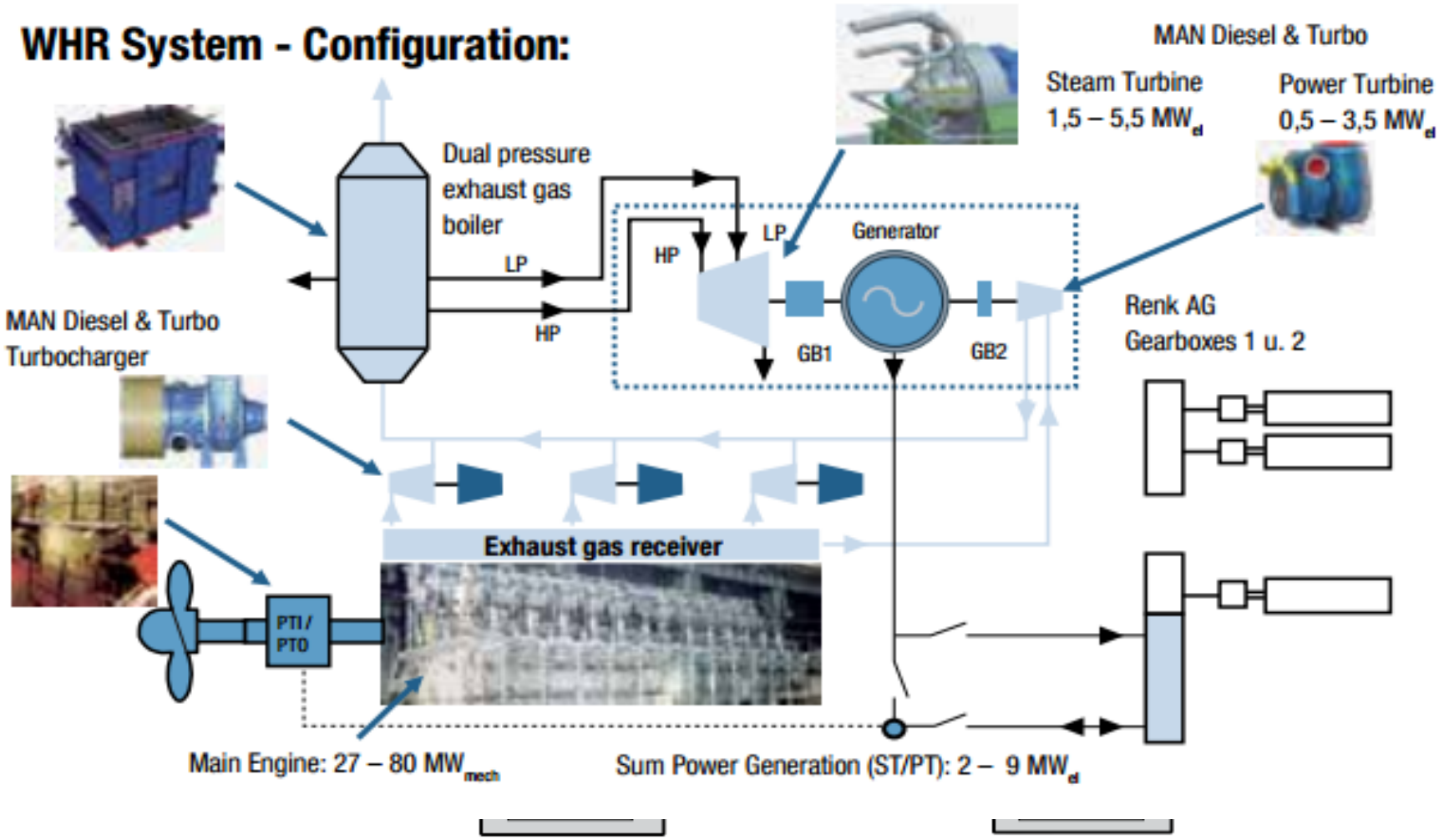
Christian Laksmono

Background of Thesis

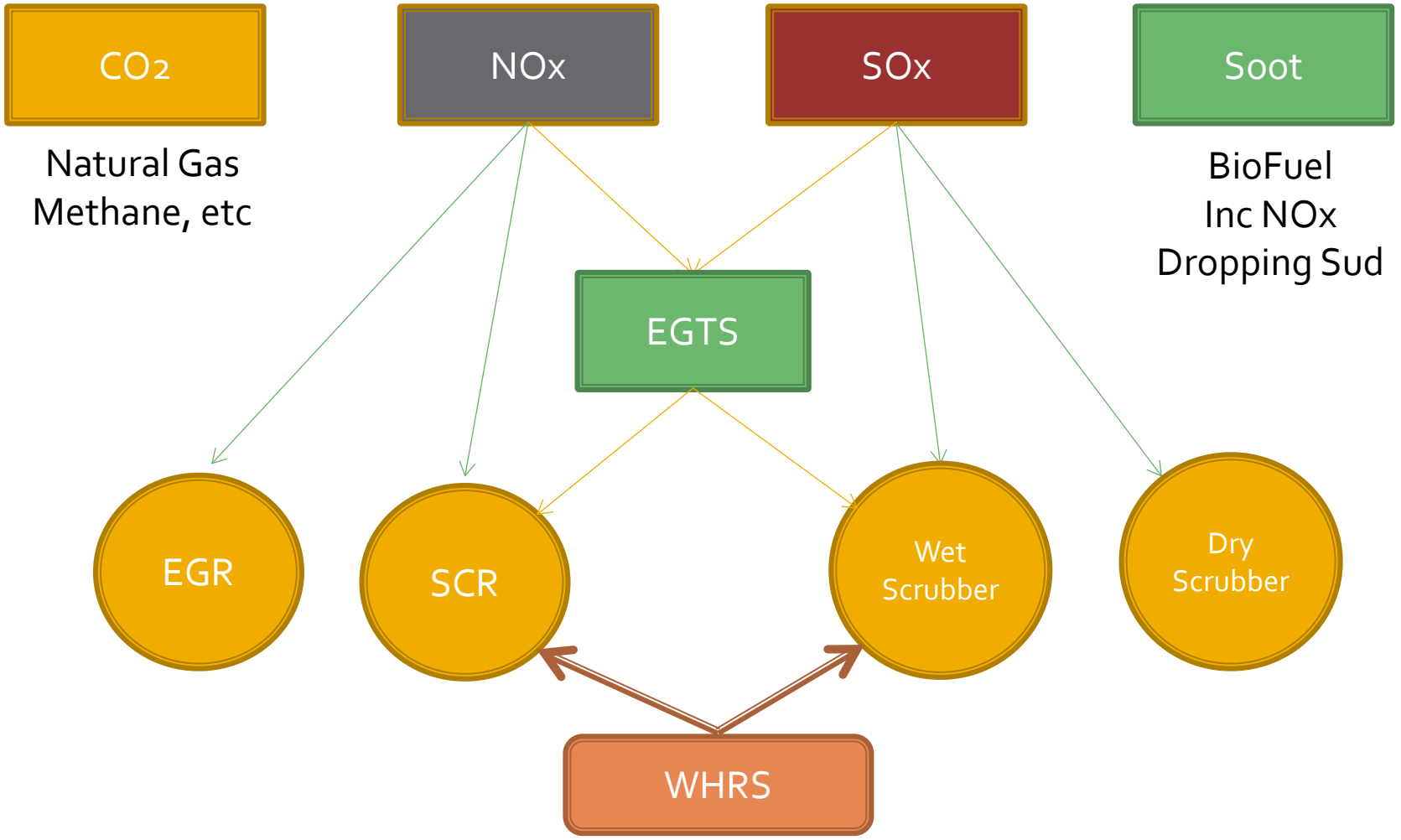


Environmental and WHRS Issues

EXISTING & FUTURE REGULATIONS



Exhaust Gas Pollution



Christian Laksmono

Bachelor Thesis Title :

THE INFLUENCE OF EXHAUST GAS TREATMENT SYSTEM TO THE POSSIBLE EXHAUST GAS HEAT RECOVERY

Using 960 Kw Machinery in Hochschule Wismar

Task + Hypothesis

1. Characterisation of different technical and operational systems to meet the SO_x and NO_x emission limits
2. Detailed description of influence of different exhaust gas treatment systems regarding the heat recovery potential
3. Appointment of exhaust gas heat recovery potential in an example
4. Evaluation of results

TASK

Hypothesis

1. Different EGTS Installment = Different WHRS Potential
2. Scrubber Influence WHRS
3. WHRS + EGTS = Improvable

Steps through Processing

1. Pipe Calculation
2. Pipe Calculation (using Program)
3. Chemical Losses Calculation
4. Losses in Scrubber Piping
5. Scrubbing System Losses
6. Mass Flow Rate Water : Gas

Type	Data	Formula	mm	metre

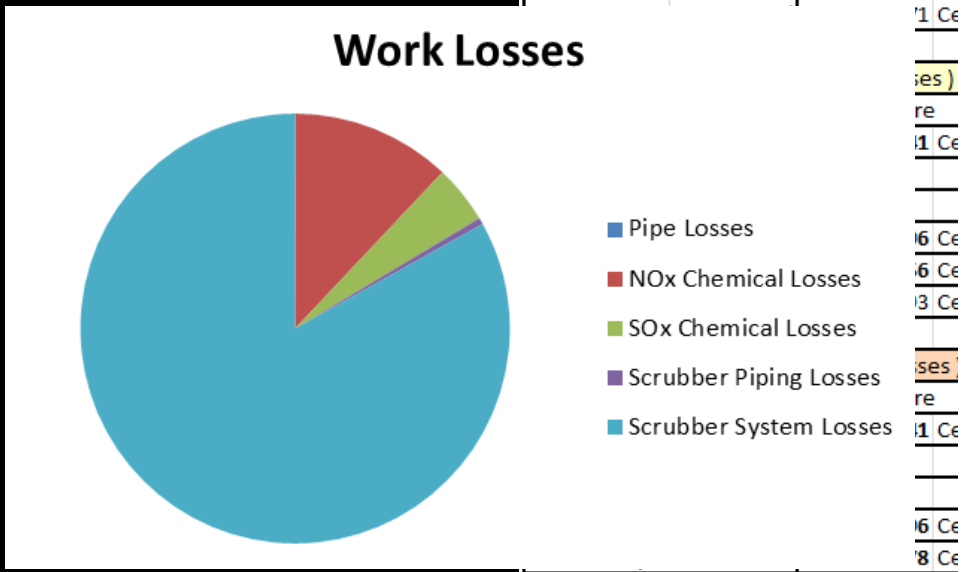
Mass Flow Rate Water	E water Open Loop	E in (gas + open loop)	E water Closed Loop	E in (gas + Closed loop)
1.64	2009.53	2937.56	1975.24	2903.27
3.28	4019.07	4947.10	3950.48	4878.51
4.92	6028.60	6956.63	5925.73	6853.75
6.56	8038.14	8966.16	7900.97	8829.00
8.20	10047.67	10975.70	9876.21	10804.24
9.84	12057.21	12985.23	11851.45	12779.48

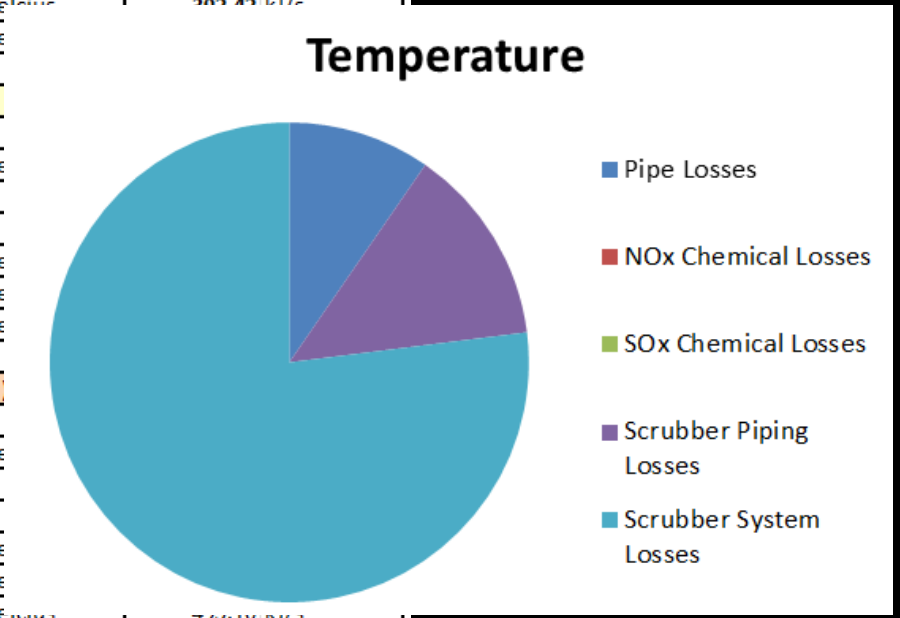
Mass flow rate Water / Mass flow Rate Gas

T gas out Open Loop *(in Celcius)*	T gas out Closed Loop *(in Celcius)*	Mass flow rate Water / Mass flow Rate Gas
41.71	37.72	1.00
34.29	29.84	2.00
31.43	26.81	3.00
29.92	25.21	4.00
28.98	24.22	5.00
28.34	23.54	6.00

A	B	C

Summary of Calculation (Best Losses)				
	Temperature		Work Losses	
Pipe Losses	**29.41**	Celcius	**0.26**	kJ/s
NOx Chemical Losses			**28.43**	kJ/s
SOx Chemical Losses			**4.53**	kJ/s
Scrubber Piping Losses	**40.96**	Celcius	**2.33**	kJ/s
Scrubber System Losses	**233.34**	Celcius		
Total	308.16	Celcius		





Summary of Calculation (without EGTS)				
	Temperature		Work Losses	
Pipe Losses	**29.41**	Celcius	**0.26**	kJ/s
Scrubber Piping Losses	**40.96**	Celcius	**2.33**	kJ/s
Total	70.37	Celcius	2.58	kJ/s

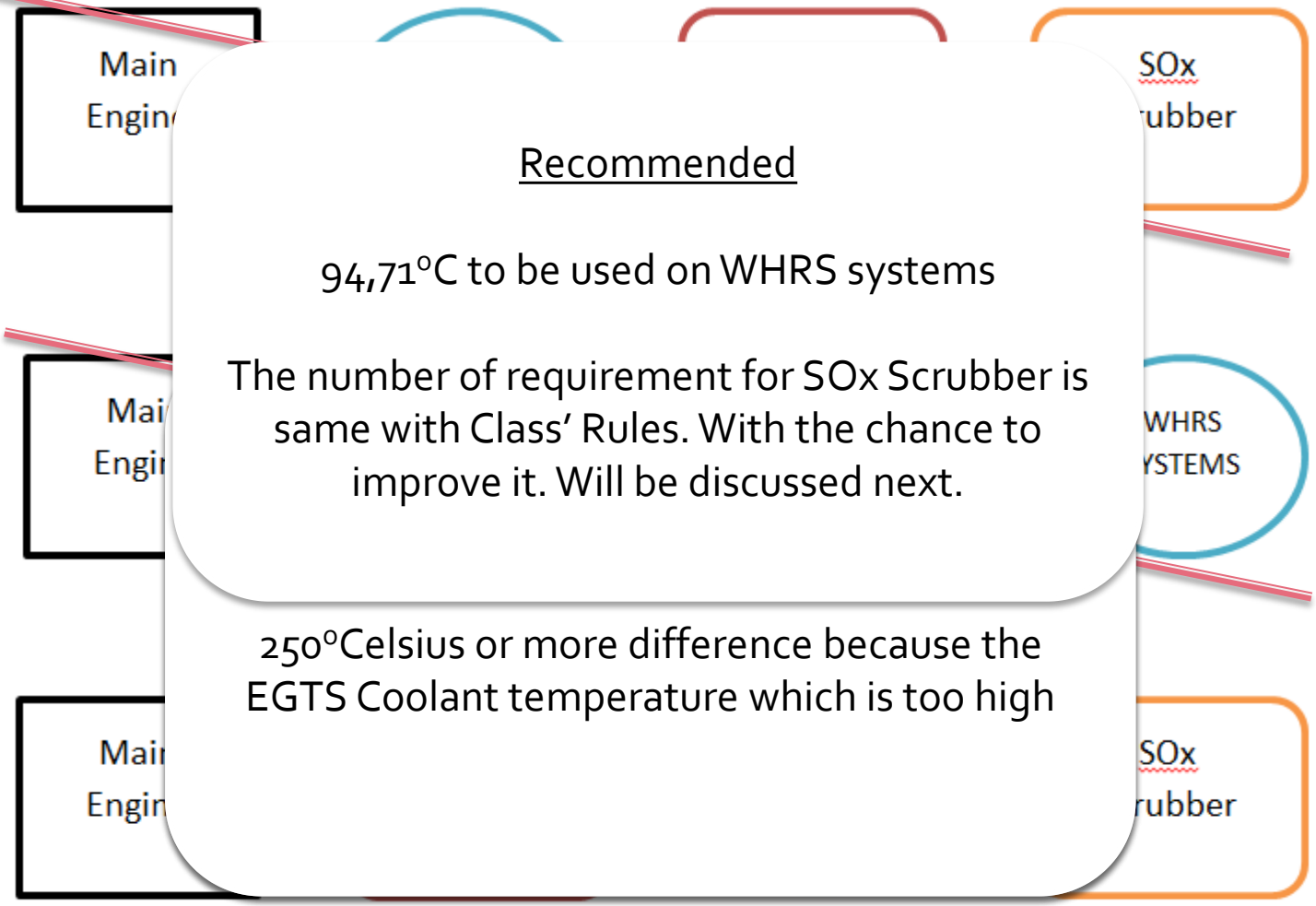
Complete Summary

Conclusion

Scrubber Analysis pre SOx Scrubber				
Summary of Calculation (Best Losses)				
	Temperature		Work Losses	
Pipe Losses	**29.41**	Celcius	**0.26**	kJ/s
NOx Chemical Losses			**28.43**	kJ/s
SOx Chemical Losses			**0.00**	kJ/s
Scrubber Piping Losses	**0.00**	Celcius	**0.00**	kJ/s
Scrubber System Losses	**0.00**	Celcius	**0.00**	kJ/s
Total	29.41	Celcius	28.69	kJ/s
Summary of Calculation (Average Losses)				
	Temperature		Work Losses	
Pipe Losses	**29.41**	Celcius	**280.75**	kJ/s
NOx Chemical Losses			**56.88**	kJ/s
SOx Chemical Losses			**0.00**	kJ/s
Scrubber Piping Losses	**0.00**	Celcius	**0.00**	kJ/s
Scrubber System Losses	**0.00**	Celcius	**0.00**	kJ/s
Total	29.41	Celcius	337.63	kJ/s
Summary of Calculation (Maximus Losses)				
	Temperature		Work Losses	
Pipe Losses	**29.41**	Celcius	**280.75**	kJ/s
NOx Chemical Losses			**63.52**	kJ/s
SOx Chemical Losses			**0.00**	kJ/s
Scrubber Piping Losses	**0.00**	Celcius	**0.00**	kJ/s
Scrubber System Losses	**0.00**	Celcius	**0.00**	kJ/s
Total	29.41	Celcius	344.27	kJ/s
Summary of Calculation (without EGTS)				
	Temperature		Work Losses	
Pipe Losses	**29.41**	Celcius	**280.75**	kJ/s
Scrubber Piping Losses	**0.00**	Celcius	**0.00**	kJ/s
Total	29.41	Celcius	280.75	kJ/s

- **EGTS does not affect WHRS**

Best Installment of EGTS ?



Recommended

94,71°C to be used on WHRS systems

The number of requirement for SOx Scrubber is same with Class' Rules. With the chance to improve it. Will be discussed next.

250°Celsius or more difference because the EGTS Coolant temperature which is too high

Figure 20 Installation WHRS (Design 3)

How to Improve EGTS (r.WHRS)

Using Better Heat Resistance Material

Summary of Calculation (Best Losses)				
	Temperature		Work Losses	
Pipe Losses	**20.1521**	Celcius	**0.256**	kJ/s
NOx Chemical Losses			**28.43**	kJ/s
SOx Chemical Losses			**4.53**	kJ/s
Scrubber Piping Losses	**40.9676**	Celcius	**2.32805773**	kJ/s
Scrubber System Losses	**233.341**	Celcius	**392.415313**	kJ/s
Total	294.4603	Celcius	427.9593709	kJ/s

Differences :			
	Temperatire		Work Losses Comparison
Best Losses	9.252717	Celcius	1.000000115
Average Losses	9.252717	Celcius	1.195701456
Maximum Losses	9.252717	Celcius	1.240546739
without EGTS	9.252717	Celcius	1.000019001

Summary of Calculation (Maximus Losses)				
	Temperature		Work Losses	
Pipe Losses	**20.1521**	Celcius	**0.256**	kJ/s
NOx Chemical Losses			**0**	kJ/s
SOx Chemical Losses			**0**	kJ/s
Scrubber Piping Losses	**40.9676**	Celcius	**2.32805773**	kJ/s
Scrubber System Losses	**237.784**	Celcius	**396.513788**	kJ/s
Total	298.904	Celcius	399.0978461	kJ/s

Summary of Calculation (without EGTS)				
	Temperature		Work Losses	
Pipe Losses	**20.1521**	Celcius	**0.256**	kJ/s
Scrubber Piping Losses	**40.9676**	Celcius	**2.32805773**	kJ/s
Total	61.1197	Celcius	2.584057729	kJ/s

How to Improve EGTS (r.WHRS)

Shorter Pipe to Reduce Heat Loss

$$Q = \frac{T\infty 1 - T\infty 2}{Rtotal} \quad and \quad Rcond = \frac{\ln(\frac{rn+1}{rn})}{2\pi k.L}$$

How to Improve EGTS (r.WHRS)

Putting Consideration into Chemical Products

Table of Comparison					
	Ca(OH)2	Mg(OH) 2	2NaOH(aq)	Sea Water :	CaCO3
Enthalpy	-161.798	-349.25	-245.57	-313.95	-48.738
Losses (kJ/kg DO)	-15.047214	-32.48025	-22.83801	-29.19735	-4.532634

Losses Analysis

	Temperature	Work Losses
Best Losses	303.71 Celcius	427.96 kJ/s
Average Losses	305.93 Celcius	474.75 kJ/s
Maximus Losses	308.16 Celcius	495.10 kJ/s
Without EGTS	70.37 Celcius	2.58 kJ/s

Combination	Pure + Nitro1	Pure+Nitro2	Aqu + Nitro1	Aqu + Nitro2	Fast Nitro
Losses (kJ/kg DO)	-67.874171	-65.653479	-62.340682	-60.1199897	-28.430928
Comparison	2.387335744	2.3092274	2.19270654	2.114598206	1
Percentage	238.73%	230.92%	219.27%	211.46%	100.00%

How to Improve EGTS (r.WHRS)

Using the Acid-Free Material on Scrubber Piping System

No Regulation for Minimum Temperature..
Acid Rain -> Non-Acid Material

Reducing 180 degree to 70 degree
We can boost up WHRS from 11% to 18.26%

If this possible than EGTS installation will boost up WHRS possibility

Thank You for Your Attention

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