Welcome To:

Energy & Environment Conservation in Heat Tracing Systems

NPC Conference – "Efficient O & M of BOILERS"

10-11 Feb 2010

Homi R. Mullan

***Raychem* RPG Limited**

Welcome To:

Technical Session-IV: 'Generic ENCON Opportunities in Boilers': "Energy & Environment Conservation in Heat Tracing Systems"

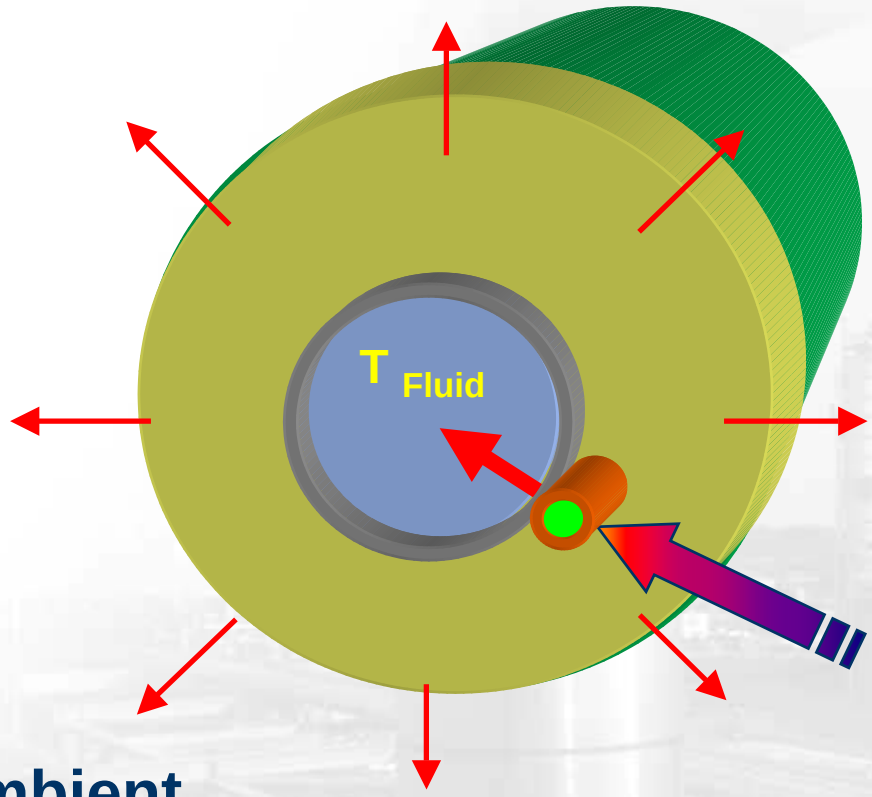
DELGATES

DIGNITORIES

PARTICIPANTS

ORGANISERS

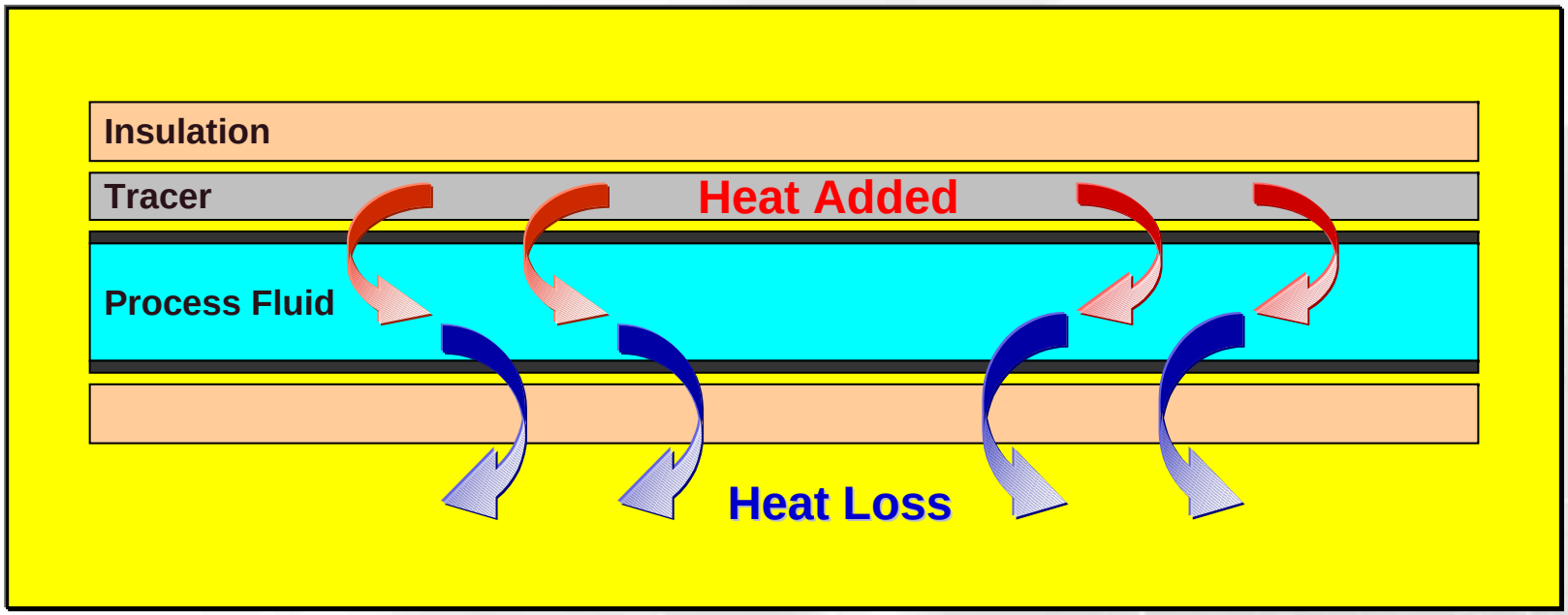
Heat Tracing -1



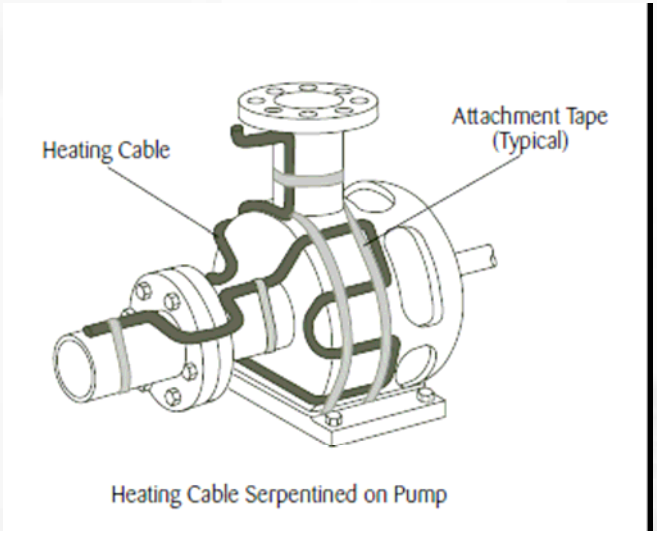
T_Ambient

Steam/ Hot Oil/ Hot Water Pipe

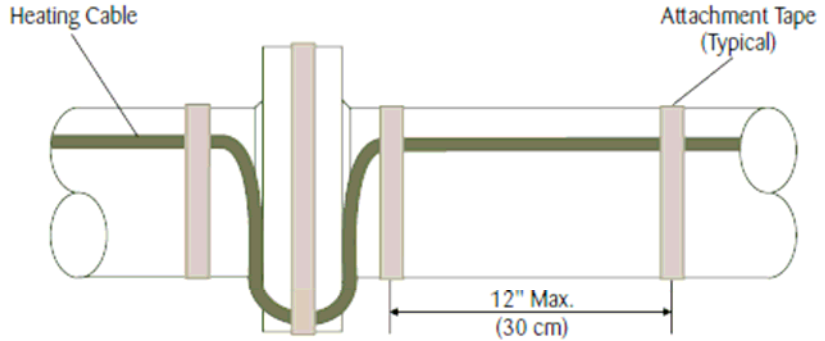
Heat Tracing - 2



Heat Tracing - 3



Heating Cable Serpentined on Pump



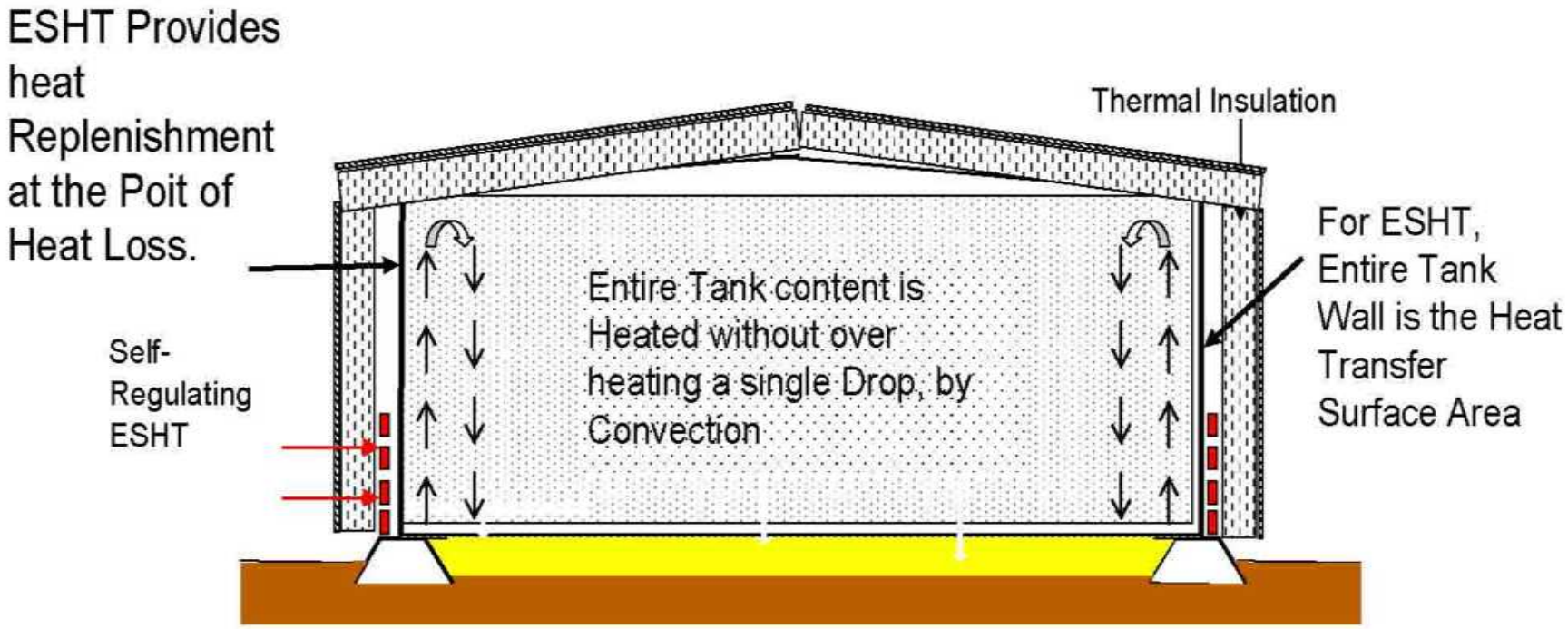
Note: Flange allowance will vary based on method of insulating flange and adjacent piping.

Raychem RPG

'Energy & Environment Conservation for Heat Tracing Systems'- by HOMI R. MULLAN

Efficient O&M Boilers-Feb.2010

Heat Tracing - 4



Electric Surface Heat Tracing (ESHT) of Crude Oil Storage Tank

ROLE of Heat Tracing in Boiler Fuels

- Maintain Pour Point Temp.
- Maintain Viscosity Temp.
- Prevent Solidification
- Prevent Sludge Formation
- Prevent Condensation of Fuel Gas
- Freeze Protection- Coal Conveyors

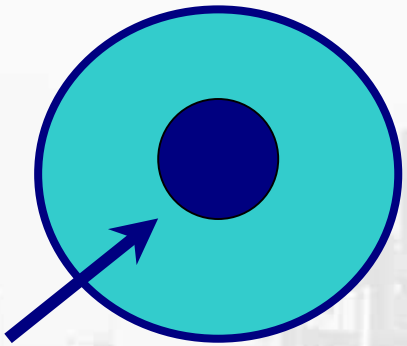
ILL EFFECTS of Over Heating of Boiler Fuels

- HOT Spot
- CARBONISATION Causing:

- Erosion of Burner Atomizing Nozzles, increasing Fuel Consumption by a Fraction %
- Retarding of Heat Transfer from Oil immersed Steam Coils of Tanks.
- Reducing Nominal Bore of Fuel Oil Lines.

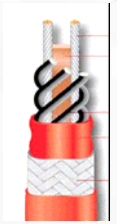
FOCUS of the Subject Paper

- **Energy Efficiency in Heat Tracing Systems: Case Studies Steam & Electric**
- **There is NO FREE or EXCESS Steam from Turbine Backpressure.**
- **Carbon Dioxide Emission Reduction Impact by Energy Savings in Heat Tracing Systems.**



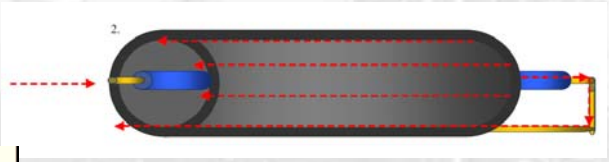
CHOICES - Modern Heat Tracing Systems- 1

- **Electric – Fibre Core SLSR**



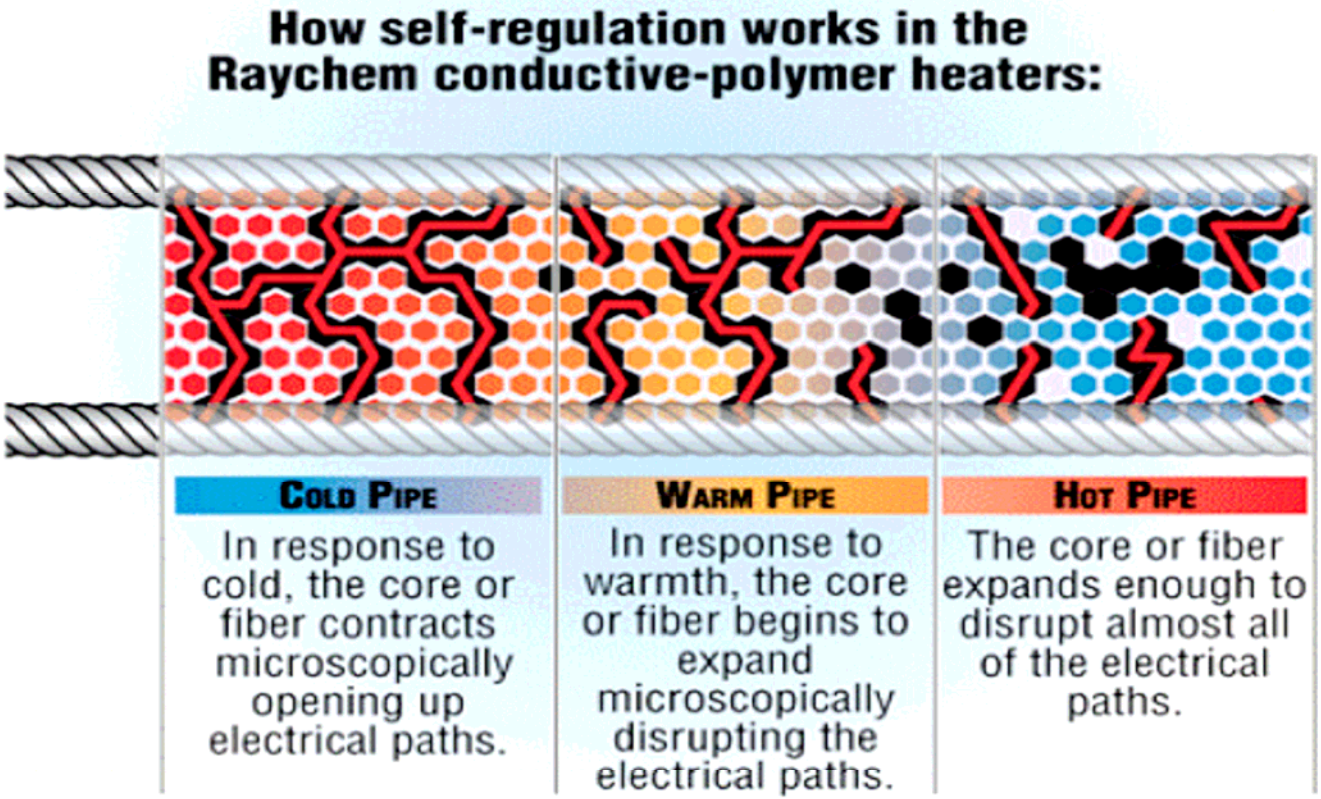
- **Electric - PTC Coiled Metal Alloy**

- **Electric- Skin Trace System**



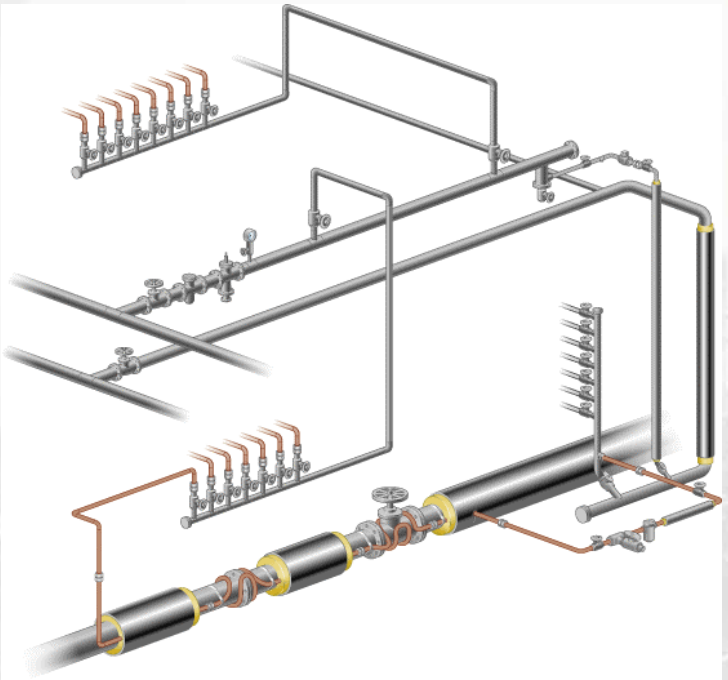
- **Steam – Reduced Output Tracers**

SELF REGULATING SELF LIMITING - Modern Electric Heat Tracers



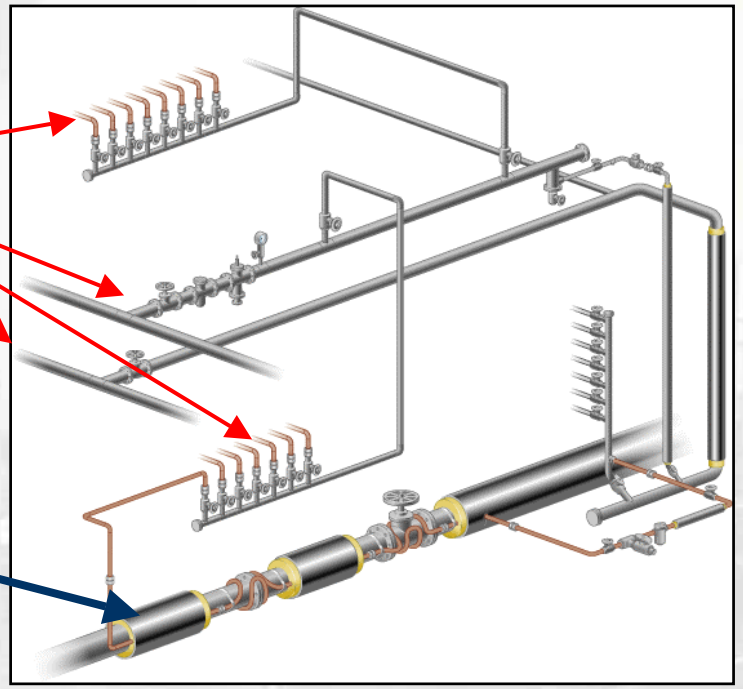
Steam Tracing- Energy Distribution

- **UNCONTROLLED Tracer Steam Consumption: Fluid in FLOW & NO-FLOW Condition**
- **RADIATION Loses from Insulated and Bare Surfaces.**
- **STEAM TRAPS Operating Energy**
- **STEAM LEAKAGES**



Steam Tracing- Energy Distribution

Energy Wastes through RADIATION Heat Loss & Steam LEAKS from Steam Mains, Manifolds, before the work is done.



Required Work to be Done, i.e., to REPLENISH Heat Loss

Steam Tracer Output Efficiency

Roger L. Decker- 'Electric Vs Steam Energy for Pipe-Line Tracing'. IEEE Vol.IGA-6, No.5, Sept.-Oct 1970

Conclusion

From an energy-cost view, electrical tracing is most economically used.

1. Under stagnant conditions at lower pipe-line temperatures and,

2. Under most flow conditions, especially when the temperature of the entering fluid exceeds the required line temperature.

Steam Tracer Output Efficiency

Roger L. Decker- ‘Electric Vs Steam Energy for Pipe-Line Tracing’. IEEE Vol.IGA-6, No.5, Sept.-Oct 1970

The maximum economical temperature of electric tracing increases with an increase in the percent of flow time and with an increase in the rate of flow. Steam tracing becomes more efficient as the desired line temperature approaches the temperature of the steam tracer.

Steam Trap Losses

Do My Steam Traps Waste Steam? [Ref. A Spirax-Sarco Publication]

All this is a reminder that traps can "waste" (or use) steam either through the trap or from the trap. Unfortunately, so-called trap testing concentrates on losses through the trap while losses from the trap are ignored. Radiation losses can be as high as 1·5 kg/h (3·5 lb/h). Lagging the bucket trap will reduce losses from the trap but these may be translated to losses through the trap. In other cases lagging will cause traps to stay shut so that unacceptable waterlogging will take place.

Steam Trap Operating Energy

The Energy Requirement of Steam Traps. [Ref. A Spirax-Sarco Publication]

Energy Requirement of Traps

(expressed in kg/h of steam equivalent)

	NO LOAD			REASONABLE LOAD		
	Through Trap	From Trap	Total	Through Trap	From Trap	Total
Thermostatic	0.5	0.5	1.0	Nil	0.5	0.5
Float	Nil	1.4	1.4	Nil	1.4	1.4
I.B.	0.5	1.2	1.7	Nil	1.2	1.2
Thermodynamic	0.5	0.25	0.75	Nil	0.25	0.25

RADIATION Losses from Steam System

From Insulated & Bare Surfaces **[Table Ref. A Spirax-Sarco Publication]**

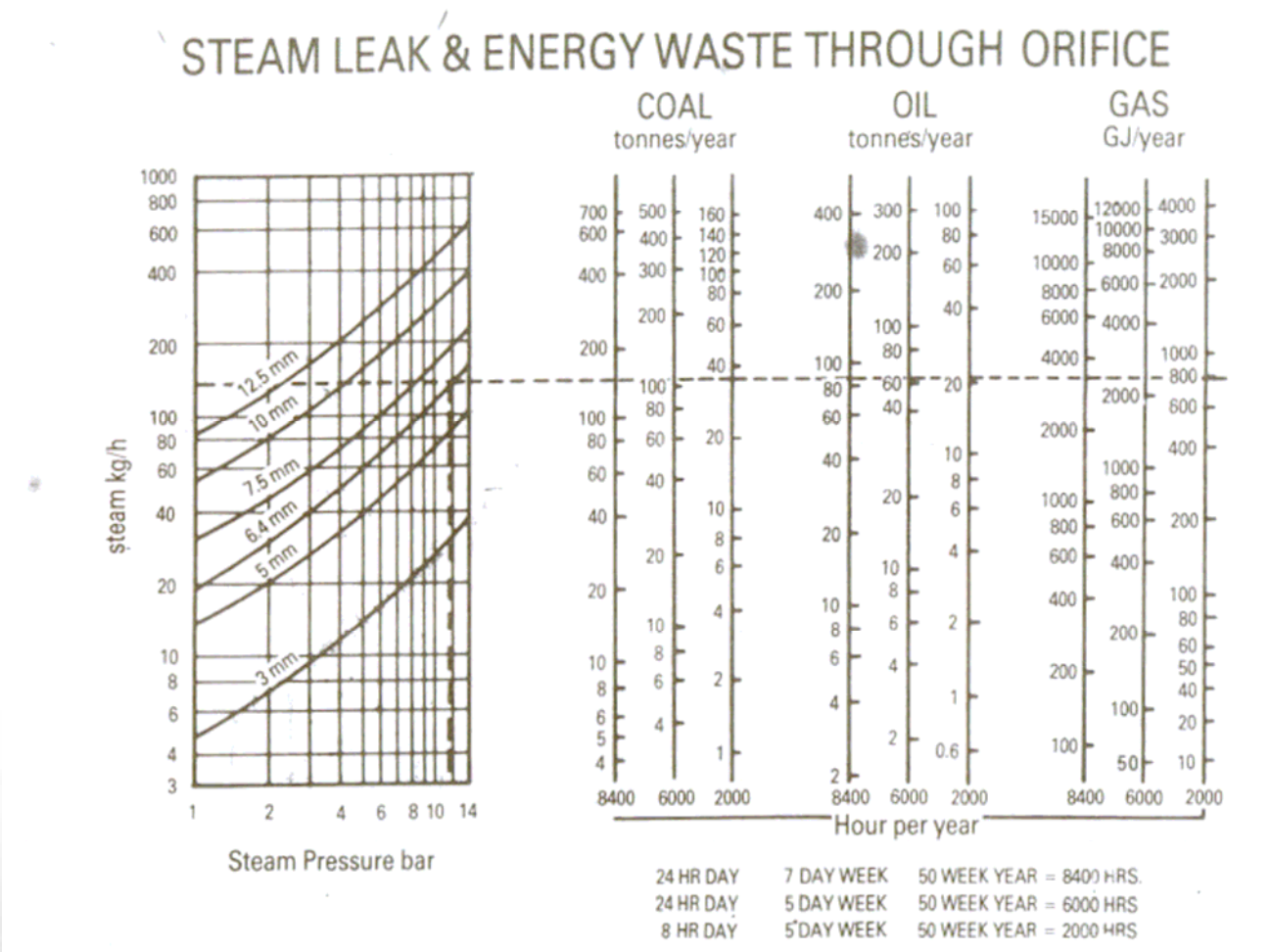
CONDENSATE LOAD IN KILOGRAMS PER HOUR PER 100 M OF INSULATED STEAM MAIN

Ambient Temperature 21°C – Insulation 80% Efficient

Steam Pressure (bar)	Main Size 50 mm	65 mm	80 mm	100 mm	125 mm	150 mm	200 mm	250 mm	300 mm	350 mm	400 mm	450 mm	500 mm	600 mm	–18°C Correction Factor†
0.7	9	10	13	16	19	24	30	36	44	48	54	59	66	80	1.580
2.0	11	13	16	20	24	29	37	46	55	60	69	73	82	128	1.500
4.0	15	18	21	28	37	42	51	63	75	83	95	103	114	137	1.480
7.0	18	22	26	32	41	48	60	75	89	98	113	122	136	163	1.410
12.0	24	28	34	39	49	57	79	99	117	129	147	160	178	212	1.370
16.0	29	35	43	54	67	80	99	123	147	162	186	202	224	269	1.355
20.0	31	38	46	57	71	83	105	131	155	170	194	212	237	283	1.340
28.0	34	41	50	63	78	92	117	145	173	191	217	237	264	317	1.320
35.0	41	50	59	74	92	110	137	172	204	223	257	279	311	371	1.310
42.0	45	59	66	83	103	124	155	193	229	252	288	314	350	418	1.300

† For outdoor temperature of – 18°C, multiply load value in table for each main size by correction factor.

STEAM LEAKGE Losses from Steam System



[Table Ref. A Spirax-Sarco Publication]

Raychem RPG

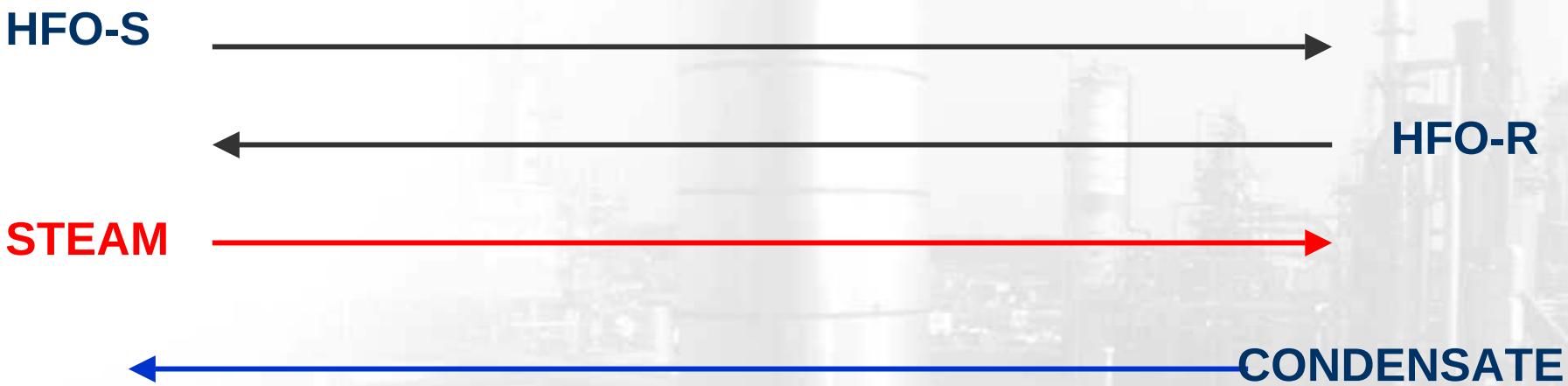
‘Energy & Environment Conservation for Heat Tracing Systems’- by HOMI R. MULLAN

Efficient O&M Boilers-Feb.2010

Case Study-1: Thermal Power Station (Yard HFO Piping)

Pour Point <=66 deg.C **Maintenance 85 deg.C**

80NB HFO Supply line 500M; 80NB HFO Return Line 500M



80NB Steam 500M; **80NB Condensate 500M**

Case Study-1: Thermal Power Station (Yard HFO Piping)

Pour Point <=66 deg.C Maintenance 85 deg.C

80NB HFO Supply line 500M; 80NB HFO Return Line 500M

Tracer (NO FLOW)	66 kg/hr	**ELECTRIC**
Tracer (FLOW)	536 kg/hr	**SLSR**
Steam Trap	125 kg/hr	
Steam Mains	130 kg/hr	
Steam Leaks	252 kg/hr	
TOTAL	**1103 kg/hr**	**31.2 kW**
Kcal/hr	**721515**	**26832**
80NB Steam 500M;	**80NB Condensate 500M**	

Steam to Electric Ratio

26.9

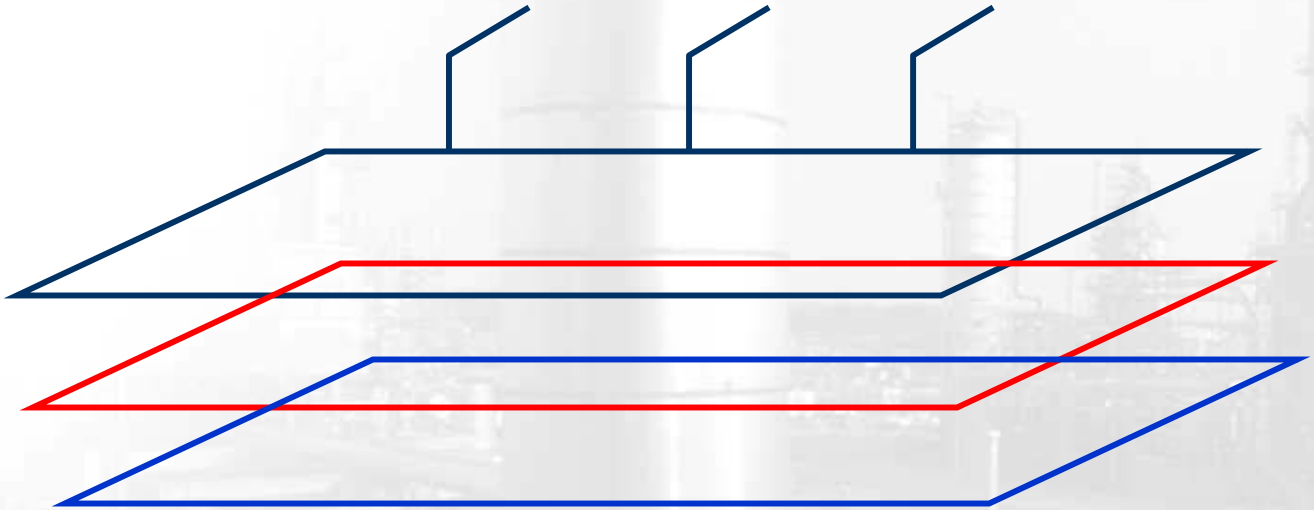
Case Study-2: Thermal Power Station (Boiler Area)

Pour Point >66 deg.C

Maintenance 85 deg.C

50 NB Boiler Area 900M;

50NB Boiler Front 300M



50NB Steam 900M;

50NB Condensate 900M

Case Study-2: Thermal Power Station (Boiler Area)

Pour Point >66 deg.C Maintenance 85 deg.C

50 NB Boiler Area 900M; 50NB Boiler Front 300M

Tracer (NO FLOW)	53 kg/hr	**ELECTRIC**
Tracer (FLOW)	428 kg/hr	**SLSR**
Steam Trap	162 kg/hr	
Steam Mains	162 kg/hr	
Steam Leaks	202 kg/hr	
TOTAL	**1007 kg/hr**	**31.2 kW**
Kcal/hr	**655154**	**33368**

Steam to Electric Ratio

19.6

50NB Steam 900M; 50NB Condensate 900M

Case Study-3: Refinery (LSHS Transfer Line)

Pour Point >66 deg.C **Maintenance 85 deg.C**

250NB LSHS Transfer line 1500M;

LSHS TRANSFER

STEAM

CONDENSATE

80NB Steam 1500M; **80NB Condensate 1500M**

Case Study-3: Refinery (LSHS Transfer Line)

Pour Point >66 deg.C **Maintenance 85 deg.C**

250NB LSHS Transfer line 1500M;

Tracer (NO FLOW)	323 kg/hr	**ELECTRIC**
Tracer (FLOW)	1506 kg/hr	**SLSR**
Steam Trap	66 kg/hr	
Steam Mains	645 kg/hr	
Steam Leaks	251 kg/hr	
TOTAL	**2791 kg/hr**	**45 kW**
Kcal/hr	**1815825**	**38700**

Steam to Electric Ratio

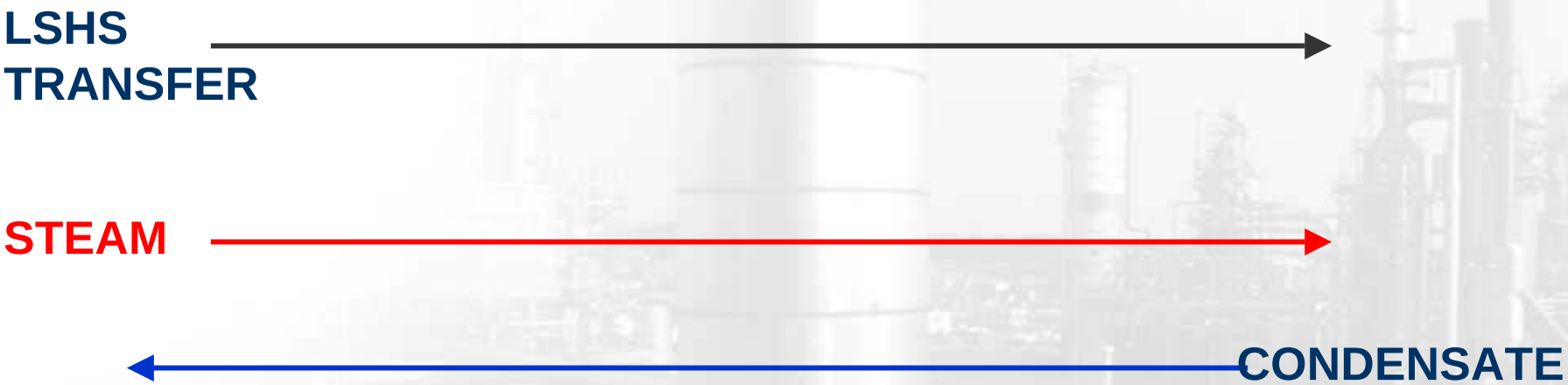
46.9

80NB Steam 1500M; **80NB Condensate 1500M**

Case Study-4: Refinery (ASPHALT Transfer Line)

Pour Point >66 deg.C **Maintenance 120 deg.C**

250NB ASPHALT Transfer line 1500M;



80NB Steam 1500M; **80NB Condensate 1500M**

Case Study-4: Refinery (ASPHALT Transfer Line)

Pour Point >66 deg.C **Maintenance 120 deg.C**

250NB ASPHALT Transfer line 1500M;

Tracer (NO FLOW)	645 kg/hr	**ELECTRIC**
Tracer (FLOW)	2409 kg/hr	**SLSR**
Steam Trap	235 kg/hr	
Steam Mains	665 kg/hr	
Steam Leaks	501 kg/hr	
TOTAL	**4455 kg/hr**	**73 kW**
Kcal/hr	**2898423**	**62780**

Steam to Electric Ratio

46.2

80NB Steam 1500M; **80NB Condensate 1500M**

Case Study-5: Process Industry (Unload & Transfer Yard Line)

Pour Point >66 deg.C

Maintenance 85 deg.C

100NB Unloading line 50M;

80NB Transfer Line 450M

LSHS TRANSFER

STEAM

CONDENSATE

80NB Steam 450M;

80NB Condensate 450M

Case Study-5: Process Industry (Unload & Transfer Yard Line)

Pour Point >66 deg.C **Maintenance 85 deg.C**

250NB ASPHALT Transfer line 1500M;

Tracer (NO FLOW)	36 kg/hr	**ELECTRIC**
Tracer (FLOW)	30 kg/hr	**SLSR**
Steam Trap	21 kg/hr	
Steam Mains	117 kg/hr	
Steam Leaks	90 kg/hr	
TOTAL	**294 kg/hr**	**7.85 kW**
Kcal/hr	**191276**	**6751**

Steam to Electric Ratio

28.3

80NB Steam 450M; **80NB Condensate 450M**

Raychem RPG

Case Study-6: Refinery (OBL Transfer Line) Vacuum Residue

Pour Point >66 deg.C

600NB VR Line 3,000M;

Maintenance 190 deg.C

300NB VR Line 2,530M

200NB Steam Line 3,500M at 42.2 bar(g) ; Condensate discharge to ground

Case Study-6: Refinery (OBL Transfer Line) Vacuum Residue

Pour Point >66 deg.C **Maintenance 190 deg.C**

600NB VR Line 3,000M; **300NB VR Line 2,530M**

Tracer (600 NB)	8562 kg/hr	**ELECTRIC**
Tracer (300NB)	3718 kg/hr	**STS**
Steam Trap	295 kg/hr	
Steam Mains	5425 kg/hr	
Steam Leaks	473 kg/hr	
TOTAL	**18483 kg/hr**	**807 kW**
Kcal/hr	**12025040**	**694020**

Steam to Electric Ratio

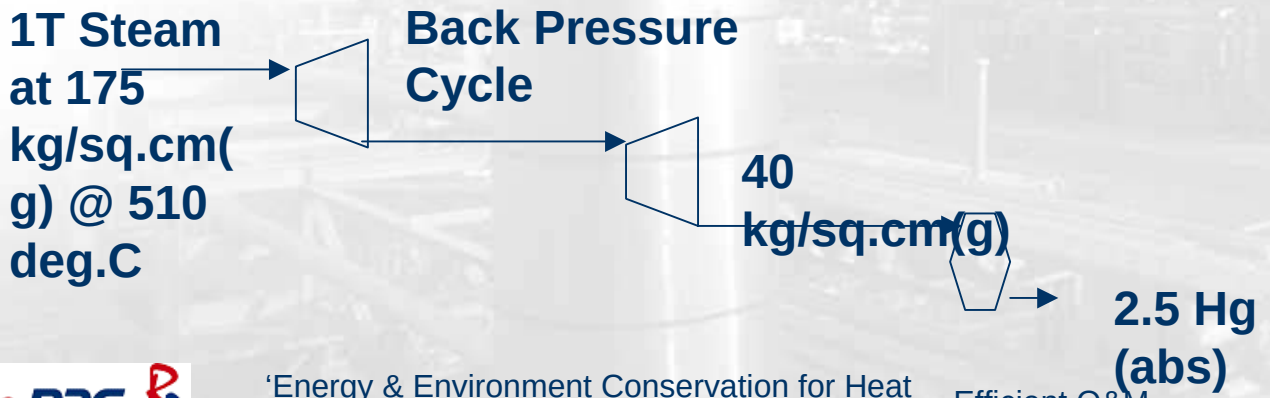
17.3

200NB Steam Line 3,500M at 42.2 bar(g) ; Condensate to ground

Steam from TURBINE & Heat-Tracing-1

Turbine Cycle Considers :

1. Adiabatic Efficiency of 80%
2. Mechanical Loss of 2.5%
3. Generator Efficiency of 97.5%

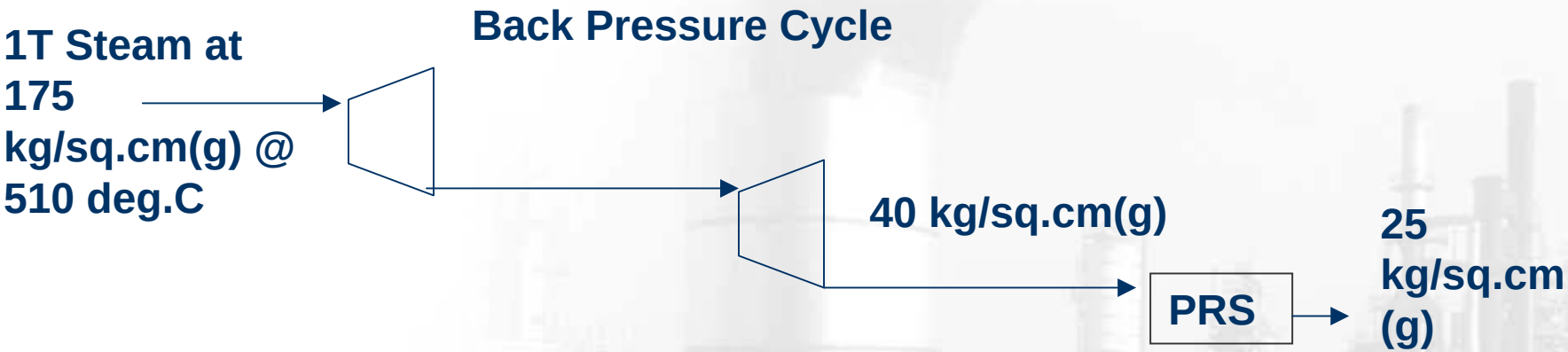


Raychem RPG

'Energy & Environment Conservation for Heat Tracing Systems'- by HOMI R. MULLAN

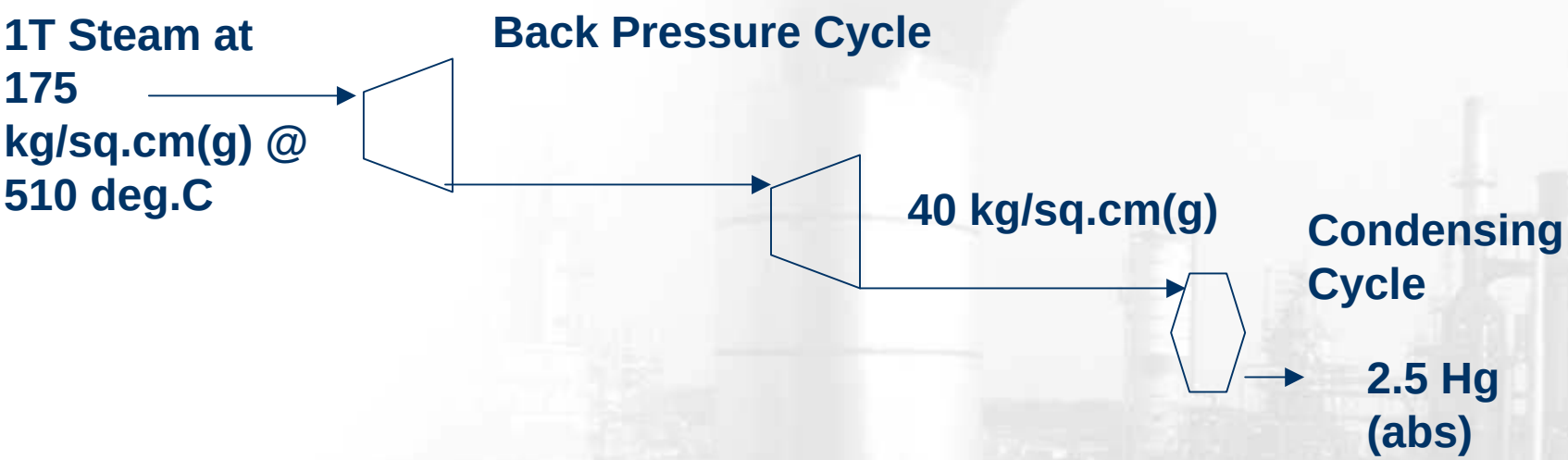
Efficient O&M Boilers-Feb.2010

Steam from TURBINE & Heat-Tracing-2



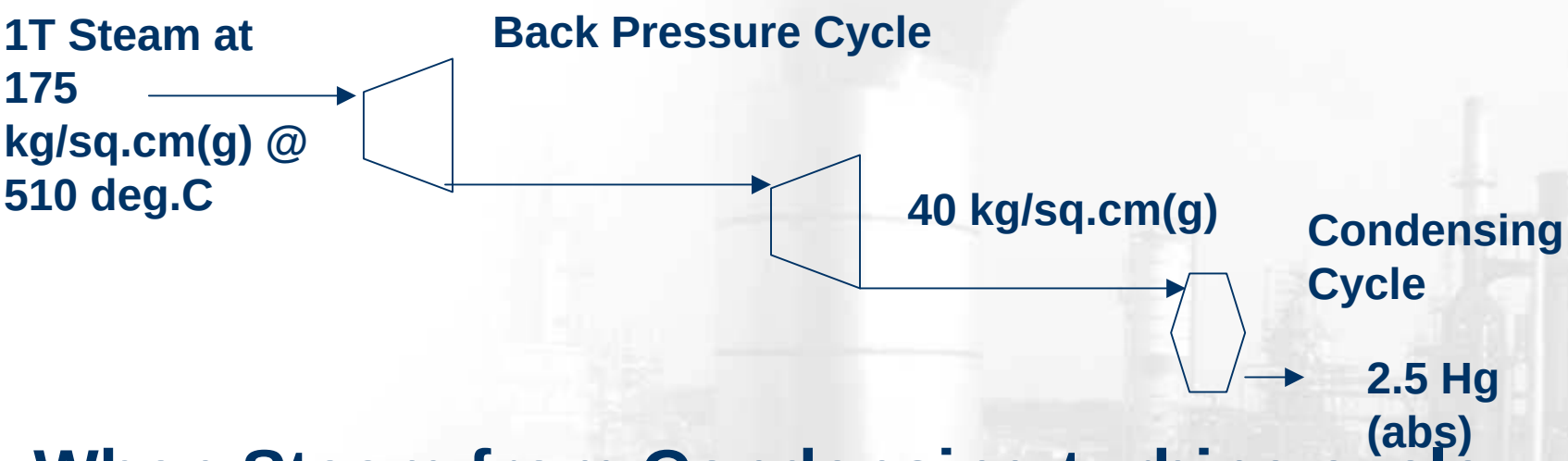
1Ton Steam at 175 kg/sq.cm(g) @ 510 deg.C, when extracted from 40 kg/sq.cm(g), would generate 82.43 kW.

Steam from TURBINE & Heat-Tracing-3



1Ton Steam at 175 kg/sq.cm(g) @ 510 deg.C, on completing condensing cycle at 2.5” Hg (abs), it would generate 280.9 kW.

Steam from TURBINE & Heat-Tracing-4



When Steam from Condensing turbine cycle is extracted from Back Pressure cycle, for auxiliary heating, there is a LOSS of 198.5 kW per Ton of Steam.

Steam from TURBINE & Heat-Tracing-5

Case	Required Power for Heat Tracing (kW)	Power by steam tracer steam (kW)	Power Saving by SR EHT (kW)	Power Saving by SR EHT (%)
1	31.2	220	189	86%
2	38.8	200	161	81%
3	45	554	509	92%
4	73	884	811	92%
5	7.9	58	51	87%
6	807	2862	3669	78%

Raychem RPG

'Energy & Environment Conservation for Heat Tracing Systems'- by HOMI R. MULLAN

Efficient O&M Boilers-Feb.2010

Energy & CO2 Emissions in Heat Tracing Systems-1

10^{12} TJ Electricity Emits 231 tonnes CO_2

10^{12} TJ Oil Emits 84 tonnes CO_2

Energy & CO2 Emissions in Heat Tracing Systems-2

CASE	Steam Tracing CO2 Emission (T/year)	Electric Tracing CO2 Emission (T/year)	CO2 Emission Saving by SR EHT (%)
1	2087	208	905%
2	1895	258	634%
3	5252	299	1654%
4	8383	486	1626%
5	553	52	959%
6	34778	5369	548%

Raychem RPG

'Energy & Environment Conservation for Heat Tracing Systems'- by HOMI R. MULLAN

Efficient O&M Boilers-Feb.2010

NPC “Choice of Heat Tracing Systems – A Study For Heavy Fuel Oils”. Feb. 1984 (1..)

- “In depth examination of different tracing systems revealed that a Self-regulating type electric tracing system scores well above other system in all aspects except that installation cost tends to be slightly high.”
- “However, this marginal difference in the investment cost is more than off-set by the very low operating costs and the difference is paid back within months.”

Raychem RPG

‘Energy & Environment Conservation for Heat Tracing Systems’- by HOMI R. MULLAN

Efficient O&M Boilers-Feb.2010

NPC “Choice of Heat Tracing Systems – A Study For Heavy Fuel Oils”. Feb. 1984 (2 ..)

- “ The overall efficiency of steam tracing, considering these losses (*i.e., various losses associated with steam tracing*) would be on an average only **16.75%** ”
- “ An efficiency level of more than **96%** could be achieved with self regulating type electric tracing if a careful selection of proper type of tracer is done.”

Raychem RPG

‘Energy & Environment Conservation for Heat Tracing Systems’- by HOMI R. MULLAN

Efficient O&M Boilers-Feb.2010

NPC “Choice of Heat Tracing Systems – A Study For Heavy Fuel Oils”. Feb. 1984 (3 ..)

- “National Perspective: Electric tracing system not only helps in conserving fossil fuels but also enables us to use more and more indigenously available coal (since electricity could be generated generated in central Thermal Power Stations) instead of importing costly petroleum fuels”
- “ It should further provide a basis for fiscal incentives by including the same in the list of energy conservation items for 100% depreciation.”

A Short History Of The Universe

Environmental Awareness: Graham Roberts-Phelps

- Think! Planet Earth as a 46 yr. Old Person, thought to be around 46 million years Old. This person is a late developer.

- First 7 yr.: Nothing is Known
- Next 35 yrs.: Sketchy information exists

A Short History Of The Universe

Environmental Awareness: Graham Roberts-Phelps

- At 42 yrs.: It began to support Life
- At 45 yrs.: Dinosaurs & Great Reptiles appear
- 8-months ago: Mammals arrived
- Mid of last week: human-like apes evolved
- At the weekend: last ice age evolved

A Short History Of The Universe

Environmental Awareness: Graham Roberts-Phelps

- About 4 hrs. ago: modern humans arrived
- During last hour: discovered Agriculture
- Just 2 min ago: Industrial revolution
- During last 60 sec, Bio-time: Humans have made a Rubbish tip of Paradise

BOILED FROG SYNDROME

JUMPS IN BOILING WATER → **JUMPS OUT INSTANTLY**

SITS IN COLD WATER, PUT TO BOIL → **SITS UNTIL IT IS BOILED, AND DIES**

THANK YOU

FOR YOUR PATIENT LISTENING