

Steam System Workshop: Going Beyond the Low Hanging Fruit

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THE UNIVERSITY OF
WAIKATO
Te Whare Wānanga o Waikato

Workshop Overview

1. Who Are We
2. Workshop Objectives
3. Definitions
 - a. Defining Efficiency
 - b. Your Energy Efficiency Tree
 - c. Defining Your Steam System
4. Steam System Applications - Ultrasound
 - a. Steam Traps
 - b. Valves
 - c. Other Unit Operations
 - d. Higher Level Opportunities



Workshop Overview

5. Demand Side Opportunities
6. Supply Side Opportunities
7. Implementation Back Home
 - a. Getting Started
 - b. Justifying Projects
 - c. Where to get Help

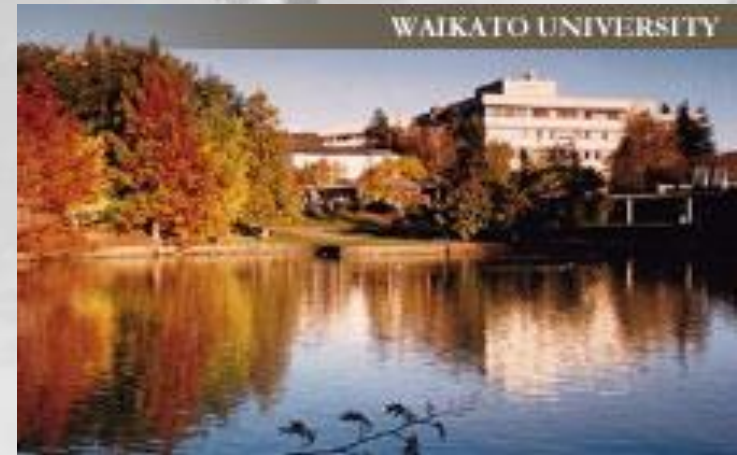


Waikato Energy Research Centre

Industrial Energy Efficiency Division

- Compressed Air
- Steam
- Utility Loop Optimisation
- Heat Recovery and Heat Integration
- Pinch Analysis
- Industrial Fluid Flow Optimisation – Liquid & Gas Transport
- Renewable Energy Solutions & Distributed Generation
- Energy Audit Methodology Development
- CO₂ Emission Reduction Programmes
- Specialised Industry Training

www.energyefficiencynz.com



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Workshop Objectives

- Leave Empowered to Take Your Energy Efficiency Program to The Next Level
- Map Out Your Energy Efficiency Tree
- Have Some Fun!



Definitions

➤ Energy Usage

- Per unit of production (Specific)
- Total production
- Net production

➤ Plant Down Time – or OPT

- Minimum stoppage times
- What is the cost of unplanned plant shut downs?
- Impacts specific energy usage

➤ Product Quality and Yield

- Impact of product quality
- Impact of variable production rates

Definitions - Efficiency

➤ Equipment Efficiency

- Individual unit efficiency
- Pump, Fan, Boiler, Trap, Heat Exchanger etc

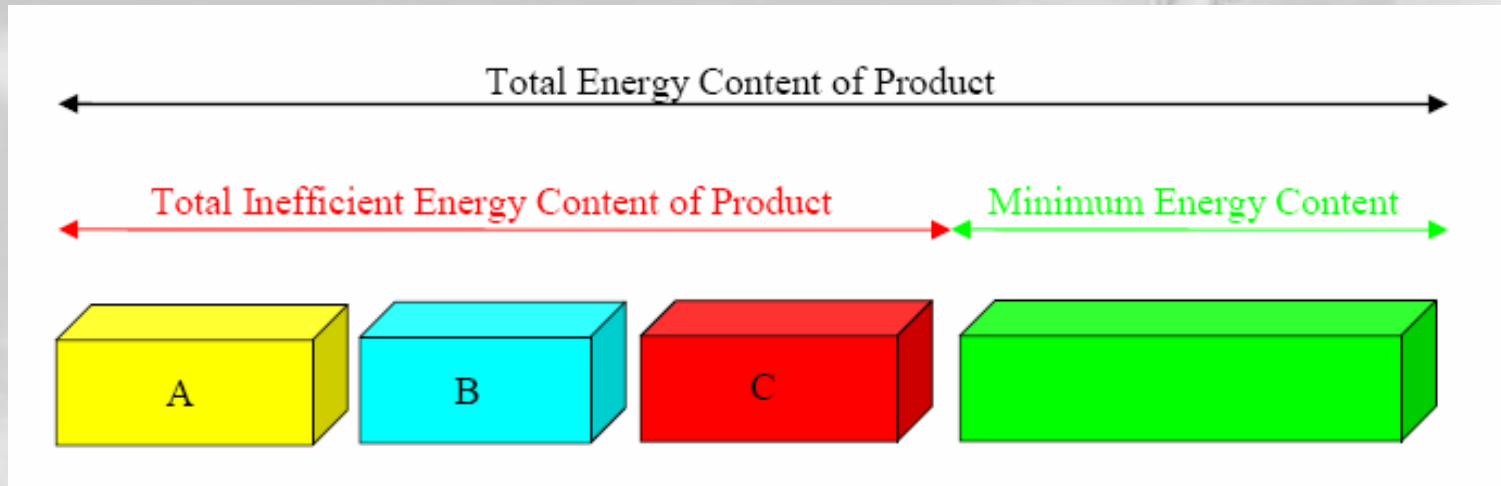
➤ Process Efficiency

- Minimise Product Waste
- Maximise Product Yields

➤ Total (Site) Energy Efficiency

- Minimum Energy Use per unit of net production

Total Energy Content of Product



This **Waste** can be broken down into :

- How we look after the plant –Maintenance & House Keeping
- How we run the plant - Process Operation & Control Decisions
- Plant Design – Built Into Plant

Efficiency Opportunities

➤ Reactive Efficiency

- Run to failure

➤ Preventive Efficiency

- Scheduled Intervention

➤ Predictive Efficiency

- Monitor Performance & Intervene Based on KPI's



Efficiency Opportunities

➤ Proactive Efficiency

- System Design/Redesign
- Equipment Selection
- Installation Excellence
 - Staff Training
 - Preferred Suppliers
 - Equipment Specifications
- System Integration
 - Process level
 - Plant Level
 - Site Level



Your Energy Efficiency Tree

- Energy Efficiency Tree – What does your tree look like?



Your Energy Efficiency Tree



How do you get to the higher fruit?

- “Low Hanging Fruit” Mindset
 - Let’s make a list?
- What does the higher fruit represent?
 - Let’s make a list?



The 4 Levels of Energy Efficiency

- **Level 0: Basic House Keeping**
 - Reactive Fire Fighting
- **Level 1: Predictive Programmes**
 - Monitor & Target Performance
 - Standardise Procedures
- **Level 2: System Optimisation**
 - Process Optimisation
- **Level 3: Site Wide System Integration**
 - Plant/Site Optimisation

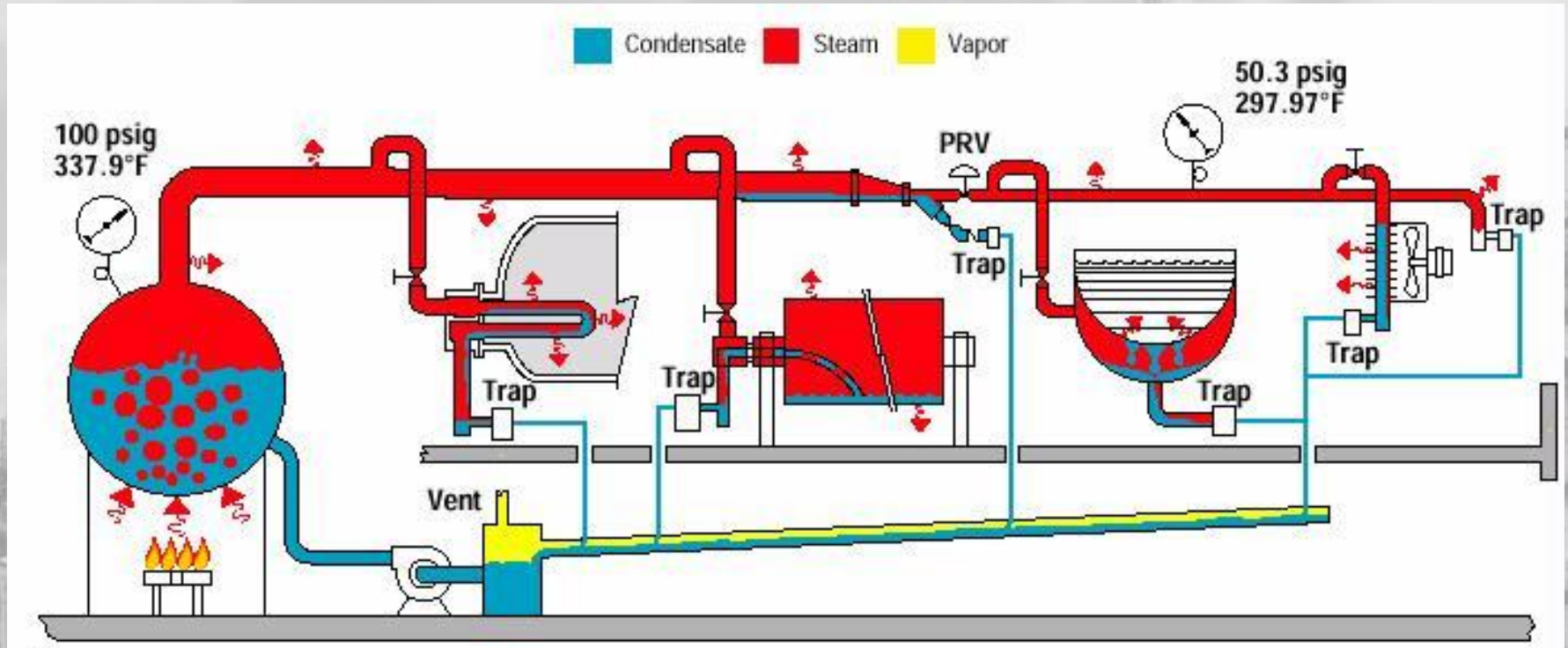


What is our Game Plan?

- Who are the Players?
 - Let's make a list?
- What they currently do?
 - Let's make a list?
- What do we need to change?
 - Let's make a list?



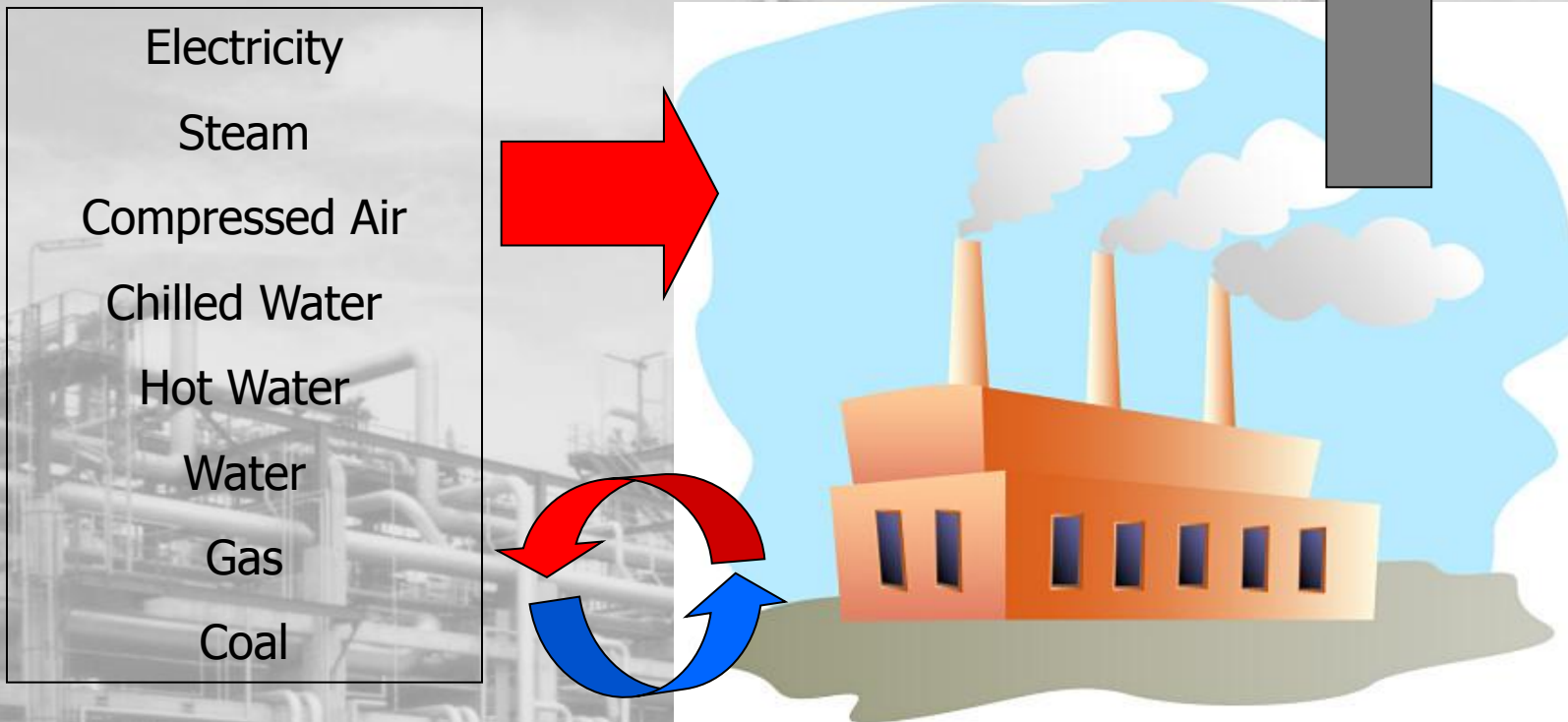
Steam System Definition



- Where do we draw the Boundary?
- What is the Function?

Steam System Definition

➤ Take a Step Back.....



Heat Recovery & Integration

Compressed Air Analogy

- Demand Side of the System
 - End Users
- Distribution network
 - Steam Distribution & Condensate Return
- Supply Side of the System
 - Boiler House

➤ Pop Quiz:

Where do you start first?



Applications for Ultrasound

- Leaks
 - Traps
 - Valves
 - Pipe Work
 - Heat Exchangers



Steam Traps

➤ Programme Options

1. No programme!
2. No Steam Pressure – better get someone in?
3. Regular Trap Surveys – Check & Replace
4. Condition Monitoring of Traps
5. Data Management



Discussion

1. In House or Out Source?
2. Survey Timing – When?
3. Criticality – Are all traps equal?
4. Condition Monitoring & Data Collection
 - What, When, Why.....?

Steam Leak Cost

- What factors determine the cost of a steam leak?
 - Pressure
 - (Pressure Differential)
 - Orifice Size
 - Steam Cost
- Anything else?
-
-

Steam Leak Costs

Orifice	2 psi	5	10	15	25	50	75	100	125	150	200	250	300
Steam Loss, lb / hr													
1/32"	0.31	0.49	0.7	0.85	1.14	1.86	2.58	3.3	4.02	4.74	6.17	7.61	9.05
1/16"	1.25	1.97	2.8	3.4	4.6	7.4	10.3	13.2	16.1	18.9	24.7	30.4	36.2
3/32"	2.81	4.44	6.3	7.7	10.3	16.7	15.4	29.7	36.2	42.6	55.6	68.5	81.5
1/8"	4.5	7.9	11.2	13.7	18.3	29.8	41.3	52.8	64.3	75.8	99	122	145
5/32"	7.8	12.3	17.4	21.3	28.5	46.5	64.5	82.5	100	118	154	190	226
3/16"	11.2	17.7	25.1	30.7	41.1	67	93	119	145	170	222	274	326
7/32"	15.3	24.2	34.2	41.9	55.9	91.2	126	162	197	232	303	373	443
1/4"	20	31.6	44.6	54.7	73.1	119	165	211	257	303	395	487	579
9/32"	25.2	39.9	56.5	69.2	92.5	151	209	267	325	384	500	617	733
5/16"	31.2	49.3	69.7	85.4	114	186	258	330	402	474	617	761	905
11/32"	37.7	59.6	84.4	103	138	225	312	399	486	573	747	921	1,095
3/8"	44.9	71	100	123	164	268	371	475	578	682	889	1,096	1,303
13/32"	52.7	83.3	118	144	193	314	436	557	679	800	1,043	1,286	1,529
7/16"	61.1	96.6	137	167	224	365	506	674	787	928	1,210	1,492	1,774
15/32"	70.2	111	157	192	257	419	580	742	904	1,065	1,389	1,713	2,037
1/2"	79.8	126	179	219	292	476	660	844	1,028	1,212	1,580	1,949	2,317

Steam Leak Costs

Orifice	2 psi	5	10	15	25	50	75	100
Annual Cost @ \$10/1000 lb								
1/32"	\$27	\$43	\$61	\$74	\$100	\$163	\$226	\$289
1/16"	\$110	\$173	\$245	\$298	\$403	\$648	\$902	\$1,156
3/32"	\$246	\$389	\$552	\$675	\$902	\$1,463	\$1,349	\$2,602
1/8"	\$394	\$692	\$981	\$1,200	\$1,603	\$2,610	\$3,618	\$4,625
5/32"	\$683	\$1,077	\$1,524	\$1,866	\$2,497	\$4,073	\$5,650	\$7,227
3/16"	\$981	\$1,551	\$2,199	\$2,689	\$3,600	\$5,869	\$8,147	\$10,424
7/32"	\$1,340	\$2,120	\$2,996	\$3,670	\$4,897	\$7,989	\$11,038	\$14,191
1/4"	\$1,752	\$2,768	\$3,907	\$4,792	\$6,404	\$10,424	\$14,454	\$18,484
9/32"	\$2,208	\$3,495	\$4,949	\$6,062	\$8,103	\$13,228	\$18,308	\$23,389
5/16"	\$2,733	\$4,319	\$6,106	\$7,481	\$9,986	\$16,294	\$22,601	\$28,908
11/32"	\$3,303	\$5,221	\$7,393	\$9,023	\$12,089	\$19,710	\$27,331	\$34,952
3/8"	\$3,933	\$6,220	\$8,760	\$10,775	\$14,366	\$23,477	\$32,500	\$41,610
13/32"	\$4,617	\$7,297	\$10,337	\$12,614	\$16,907	\$27,506	\$38,194	\$48,793
7/16"	\$5,352	\$8,462	\$12,001	\$14,629	\$19,622	\$31,974	\$44,326	\$59,042
15/32"	\$6,150	\$9,724	\$13,753	\$16,819	\$22,513	\$36,704	\$50,808	\$64,999
1/2"	\$6,990	\$11,038	\$15,680	\$19,184	\$25,579	\$41,698	\$57,816	\$73,934

Steam Leak Costs

Orifice	50 psi	75	100	125	150	200	250	300
Annual Cost @ \$10/1000 lb								
1/32"	\$163	\$226	\$289	\$352	\$415	\$540	\$667	\$793
1/16"	\$648	\$902	\$1,156	\$1,410	\$1,656	\$2,164	\$2,663	\$3,171
3/32"	\$1,463	\$1,349	\$2,602	\$3,171	\$3,732	\$4,871	\$6,001	\$7,139
1/8"	\$2,610	\$3,618	\$4,625	\$5,633	\$6,640	\$8,672	\$10,687	\$12,702
5/32"	\$4,073	\$5,650	\$7,227	\$8,760	\$10,337	\$13,490	\$16,644	\$19,798
3/16"	\$5,869	\$8,147	\$10,424	\$12,702	\$14,892	\$19,447	\$24,002	\$28,558
7/32"	\$7,989	\$11,038	\$14,191	\$17,257	\$20,323	\$26,543	\$32,675	\$38,807
1/4"	\$10,424	\$14,454	\$18,484	\$22,513	\$26,543	\$34,602	\$42,661	\$50,720
9/32"	\$13,228	\$18,308	\$23,389	\$28,470	\$33,638	\$43,800	\$54,049	\$64,211
5/16"	\$16,294	\$22,601	\$28,908	\$35,215	\$41,522	\$54,049	\$66,664	\$79,278
11/32"	\$19,710	\$27,331	\$34,952	\$42,574	\$50,195	\$65,437	\$80,680	\$95,922
3/8"	\$23,477	\$32,500	\$41,610	\$50,633	\$59,743	\$77,876	\$96,010	\$114,143
13/32"	\$27,506	\$38,194	\$48,793	\$59,480	\$70,080	\$91,367	\$112,654	\$133,940
7/16"	\$31,974	\$44,326	\$59,042	\$68,941	\$81,293	\$105,996	\$130,699	\$155,402
15/32"	\$36,704	\$50,808	\$64,999	\$79,190	\$93,294	\$121,676	\$150,059	\$178,441
1/2"	\$41,698	\$57,816	\$73,934	\$90,053	\$106,171	\$138,408	\$170,732	\$202,969

Steam Trap Examples

➤ 40 Bar-g Main Steam Line



Valves, Pipe Work & Heat Exchangers

- What are we looking for?
 - Internal Leaks
 - External Leaks

- Other Problems?
 - Water Hammer
 - Condensate Lines
 - Flash Steam
 - Orifice plates v traps?

Demand Side Opportunities

- Basic Leaks & Waste
- Condensate
 - To Drain
 - Return
 - Flash Steam – can it be used?
- Pressure Minimisation
 - Lower P = Greater Heat Transfer
- Substitutes?
 - Do you need to use steam?
 - Heat recovery opportunities?

Supply Side Opportunities

➤ Fuel Conversions

➤ Coal

➤ Gas

➤ Biomass

➤ Waste

➤ Nuclear?

➤ Boiler Tuning

➤ How often?

➤ Fuel Dependent?

➤ Cleaning?



Supply Side Opportunities

- Condensate Return System
 - Insulation
 - Collection
 - Flash Steam Management
 - **Site Safety ***
- Pre-Heaters
- Make Up Water & Chemicals
- Co-Generation
- Tri-Generation



Higher level Opportunities

- Comprehensive Thermal utility Integration
 - Waste Heat Recovery
 - Thermal Storage (hot & cold)
 - Heat Integration
 - Eliminates excess heating and cooling
 - Multiple Savings
 - Steam
 - Cooling Towers
 - Refrigeration Load
- Process & Plant Re-Engineering



Thought for the Future

- If you have the same plant design that is used by your competitors, what is going to keep you ahead of them?



Review

- Steam Systems have unique characteristics that require extra special attention:
 - Limited down time
 - High Temperatures
 - Risk to people & equipment
 - Always remember – Safety first.



Implementation Back Home

➤ Getting Started

1. Where do we begin?
2. What resources do I need?
3. How do I develop my business case?
4. Where can I go for help?

➤ Software Data Logging Tools Available

- Leak Logger
- Steam Trap Manager
- Mobile Apps – Windows & Android platforms

Thank You & Good Luck!

➤ Further information:

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www.energyefficiencynz.com

