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Excess Energy from Heat-exchange Systems

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Outline of presentation

- 1. Cavitation and its power
- 2. Excess energy from triple-pipe heat exchanger (THX) heated by vapor-compression system (VCS)
- 3. Excess energy from double-pipe heat exchanger (DHX) heated by steam boiler
- 4. Conclusion
 - Q: Can excess energy be induced from a simple heat exchanging process involving cavitation, in kW scale?





1. Cavitation and its power

Cavitation Phenomenon

Cavitation is a process of liquid vaporization at a pressure lower than thermodynamic vapor pressure, which generates bubbles and creates implosion with intense shock wave or micro-jet to damage propeller or container wall etc.









Vapor bubble formation and growth

No growth till surface
breakdownBubble collapse with compression shock
wave or micro jet (Implosion)IET Institute for Energy Technology, HSR, Rapperswil, Switzerland



Propeller damage by cavitation (force and/or heat)



- Sonoluminescence (1934)
 - a LENR might occur inside extraordinarily large collapsing gas bubbles created in a liquid during <u>cavitation.</u>
 Alan J. Walton, Geo. T. Reynolds. Sonoluminescence.



>flash generated by micro-bubble collapse in 5μ s at ~5,100K

induces Low Energy Nuclear Reactions (LENR) ?

- Cu foil in a 30W ultrasonic vibrator for 7 & 21min
 Failure mechanism: both
- Failure mechanism: both mechanical and thermal ? 4

Strength of 'bubble collapse' (gas bubble dynamics)

Pressure inside micro/	$P_i - P_o = \frac{4\gamma}{r}$				
Diameter (2r)	△P (Pa)	△P (atm)			
1mm	291.2	0.00287			
500µm	582.4	0.00574			
100µm	2,912	0.0287			
50µm	5,824	0.0574			
1µm	291,200	2.87			
100nm	2,912,000	28.7			
10nm	2.912x10 ⁷	287			
1nm	2.912x10 ⁸	2,870			

https://www.youtube.com/watch?v=Ji0GAt-q2EM&list=PLZk-jCLezj9hltBOsOUtri4W_71MbX8xU&index=14

Cavitation engine (Impact chamber)

CONTROLLED CAVITATION ENERGY STEAM GENERATION (CCES)

Cavitation Energy Systems, Inc./New Energy Power System LLC

 Hydrodynamic cavitation: using conventional diesel fuel injector technology to inject a high-pressure water jet (20,000~25,000 psi at 1700 m/s) into a chamber to create cavitation and induce LENR



Measured COP= 5.25 @388 °C

Single Impact Chamber Energy Measurement



The following table summarizes the results.

Test	Chamber	Heater	Volume	Injection	Total Volume	Total Steam Produced (Ibs) @
Duration	Temperature		(mi)	Rate	(L)	388
60 minutes	388 degrees	2 at 500 watts	0.275	5/sec	4.95	10.89

Component	Input Energy KWh	Output in BTU (1250 BTU/Ib)	Output in KW	Steam Output/Electric Input Ratio
Water Pump	0.39			
Hydraulic Pump	0.19			
Heaters	0.21			
Electronics	0.0001			
Total Energy	0.791	14157	4.15	5.25

Energy revolution is coming, if COP= 10 @>400 °C using water as fuel



Research of Cavitation Machines in National Taiwan University (2018~)

- Use engineering approach according to two phenomena:
 - 1) Cavitation
 - 2) Dynamic implosion using nanobubbles



Develop two cavitation machines having COP > 1 (excess energy)

- 1) Triple-pipe heat exchanger heated by vapor-compression system (VCS)
- 2) Double-pipe heat-exchange heated by steam boiler (DHX)

2. Excess energy from triple-pipe heat exchanger heated by vaporcompression system (VCS)

- Continue testing vapor-compression system (VCS) presented in ICCF-22/Italy (2019)

Triple-pipe heat exchanger(THX) is heated by vapor compression system (VCS)

- Compressor: R22/2.75RT (3 kW input)
- No evaporator as in air conditioning system
- Use triple-pipe heat exchanger (THX)

triple-pipe heat exchanger





Develop a water-flow calorimetry to measure Q_{wnet} and Excess Energy Index COPx



Steady-state energy balance of VCS: $Q_{wnet} = W_t - Q_L$ (First law of thermodynamics) Excess energy index (COPx) (to identify occurrence of excess energy): $COP_x = \frac{Q_{wnet}}{W_t - Q_L}$ $COP_x = 1$ (without excess energy) > 1 (with excess energy) $COP_x = \frac{Q_{wnet} + Q_{ex}}{W_t - Q_L} > 1$

Test results of VCS

- VCS-1 was tested for 2 years under various operating conditions.
- Test result shows that COPx >1 (excess energy) exists and can be repeated. COPx = 1.29~1.97.
 - The compressor (Copeland) breaks down at the end of 2020 due to overheating.
- Replacing compressor with different models (VCS-2), COPx is improved after tuning for about 5 months. Maximum COPx is 2.05.





Excess heat (Qex)and total heat output (Qout) in kW scale



- For VCS-1, COPx is related to the temperature gradient (ΔT) of two streams in THX.
 ≻ Higher inlet water temperature results in lower temperature gradient (ΔT) between water and freon in THX which affects the cavitation phenomena.
- For VCS-2, it seems not so.



Several peculiar phenomena were observed

- Output steam temperature, 150°C, is higher than the compressor output refrigerant temperature (146°C) - Excess energy was generated in water. And instead, the refrigerant vapor is cooled at some part of the heat exchanger.
- Abnormally-high water line pressure (> 50 bar) was observed which broke the pressure gauge. Implies cavitation bubbles size ~ 50 nm (according to bubble dynamics). And, copper pipe was cracked and leaked.
- 3) Serious fouling happens even in a day causing blockage of water passage.
- 4) Refrigerant oil in VCS plays some role in heat transfer inside the triple-pipe heat exchanger and causes interesting heat transfer phenomena. Looks like the behaviour of oscillating heat pipes.



3. Excess energy from double-pipe heat exchanger (DHX) heated by steam boiler

• Double-pipe heat exchanger (DHX) design

Using double-pipe heat exchanger to reduce manufacturing cost
 Using steam boiler as the heat source for future large-scale application



- DHX-1 has been tested since July, 2020 under various operating conditions such as flowrates, steam temperature, water pressure, control schemes, etc.
- The first 4 months got nothing special (COP_x=1) until November, 2020.(as baseline calibration)
- The best performance of DHX-1 was found during 2020/11/14 2020/12/24 having excess energy COP_x = 1.50~2.55. Estimated cavitation bubbles size 20~30 nm.
- Copper pipe rupture and leakage was found in Feb, 2021, 6 months after installation.
- New DHX-2 (new design for stronger structure) cannot repeat the best results of DHX-1.



• The excess energy generation Q_{ex} ranges 2.15-4.18 kW which varies with boiler steam temperatures.



Peculiar phenomena observed in DHX-1

- The inner copper pipe (steam side) of DHX-1 was found deformed and the outer pipe wall (water side) was cracked and leaked, after a few hours' operation.
- The outside surface of the inner pipe (thickness 0.4mm) became shining black which contains 10-23% carbon and 20-28% oxygen.
- A huge pressure (>160 bar) or a high temperature (>500°C) results in buckling of inner pipe and rupture of outer pipe that was probably induced by LENR.



Element chemical analysis of outside surface (wt%)



- Buckling of copper pipe caused by huge pressure or high temperature
- Outside surface looks shinning black



Transmutation?

Scanning Electron Microscopy Image (SEM)

The pipe surface looks like copper oxide nanowires made from thermal oxidation.



Specimen No.1-1



Xu *et al,* Chemical Physics Letters 399 (2004) 62–66. Formation of CuO nanowires on Cu foil.



Download : Download full-size image

Fig. 4. The morphologies of the oxide scales formed on Cu foils at: (a) 300 °C, showing round oxide grains, (b) 400 °C, (c) 500 °C, (d) 600 °C, (e) 700 °C, showing nanowires with different density, size and shape, and (f) 800 °C, showing oxide crystals.

How does COPx > 1 happen in heat exchanger ? LENR ?

- 1. Water cavitation within tiny passages (~1.6 mm gap)
- 2. Intense dynamic implosion from collapse of nanobubbles (< 100nm)
- 3. Flow oscillation/resonance in heat transfer process





4. Conclusion

- 1) Excess energy in kW scale can be induced from simple heat exchanging process involving cavitation.
- 2) The test results of the present heat-exchange systems (VCS and DHX) shows that COPx > 1 exists under some design and operating conditions, which makes water become fuel.
- 3) The excess energy index (COPx) is defined on the basis of 1st law of thermodynamic and can be used in the experimental data analysis to identify the existence of excess energy phenomena.
- 4) Material problems will be eventually encountered for the machines with COPx >1 since extremely high pressure or high temperature will be induced by LENR.
- 5) The phenomenon of COPx > 1 is related to cavitation, nano-bubbles implosion, and possible LENR. More research by scientists are needed.
- 6) As engineering people, we are focusing on the duplication of the best performance obtained during the studies to provide a reliable, simple and cheap machine to harvest energy from water.
 - Current task:
 - try to repeat the best results (COPx = 2.55 or higher) of DHX-1, and leave the material problem to future engineering development.

May the dream of tomorrow come true

ITER (2035) – 20,000 Million Euro



Thank you

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