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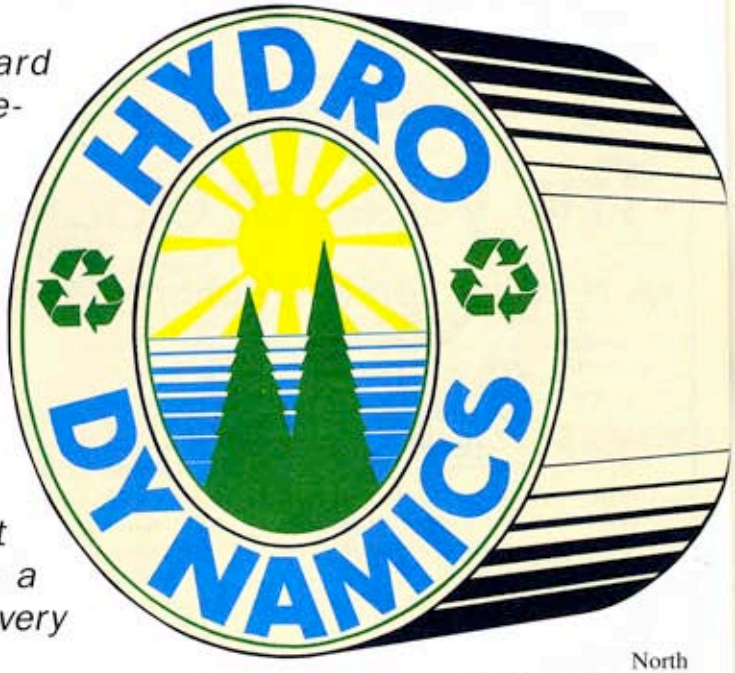
THE HYDROSONIC™ PUMP: An excess energy device?

Report on a Visit To Hydro Dynamics, Inc.

by Jed Rothwell and Eugene Mallove

Sometimes success can be so great that it is very hard to believe. Cold fusion researchers have been accustomed to electrochemical experiments in which the excess heat production is a fraction of a watt, a few watts, or even a few tens of watts. So what happens when they are confronted with a device that puts out kilowatts of apparent excess heat and seems to have nothing to do with electrochemistry? An unusual device that is being manufactured and sold by a Georgia R&D company presents that very conundrum.



Heating system and energy conservation electrical engineer James L. Griggs made the first model of his so-called "Hydrosonic pump" in 1989, but cold fusion and the Utah announcement had nothing to do with his invention. Today Griggs holds U.S. Patent 5,188,090 on the device, which was granted February 23, 1993, following his April 1991 filing. The modest title of the patent is "Apparatus for Heating Fluids," and it is assigned to Hydro Dynamics, Inc., the small Cartersville, Georgia company at which Griggs is the senior engineer.

Griggs' original intent was simply to create a device that would efficiently produce and circulate hot water or steam in a building. He certainly had no intention whatsoever of developing a machine that could produce more thermal output than the electrical energy it consumed—on its face an apparent violation of the First Law of Thermodynamics. In fact, when early tests of the device seemed to show an excess heat phenomenon, he presumed that he was making a major mistake in his calculations. He put the question of "excess heat" out of his mind for some time and continued to develop the device. Its general form is little more than a cylindrical aluminum rotor that is spun by a powerful electric motor within a cylindrical steel casing. The rotor and case fit together with close tolerances, say 0.1-inch for a rotor diameter of 12-inches. Water is forced between the rotor and the steel case by a low power, very small auxiliary pump. The rotor has holes machined into its periphery, which help create turbulent conditions in the water that is passed through the annulus between rotor and case. Company literature suggests that the Hydrosonic pump uses "mechanical shock waves (similar to the 'water hammer effect')" to accomplish the heating.

Depending on operating conditions, the Hydrosonic™ pump can produce either continuously flowing hot water, pressurized steam, or a mixture of both. Hydro Dynamics, Inc. has not gone into mass production, though the units are for sale. Several of the installations that have acquired the units for testing or permanent heating have reported that they are unusually effective. In a few operational cases, the pumps do seem to put out substantially more BTUs than the BTU-equivalent of the electricity consumed. For example, the maintenance director for the Martin County Schools (Williamston, North Carolina) testified that a Hydrosonic pump, placed in-line with an existing electric boiler heating system producing hot water, appeared to be at least 14 percent more efficient than the electric boiler. The facilities manager for Dougherty County testified that his calculations for one unit installed in an Albany, Georgia fire station as a replacement for a gas-fired system "prove [the] unit produces more energy in BTUs than it consumes."

A number of technical people have come to the Hydro Dynamics facility to try to debunk this "over-unity" performance. To date, all have failed to find an error being made in the relatively simple measurements—one large enough to make the excess heat disappear.

In August, 1993, stimulated by the cover story about cold fusion in *Popular Science*, James Griggs contacted various people in the cold fusion field to seek assistance in explaining the baffling results. This led to further investigations of the Hydrosonic pump and the report that follows. Other testing continues at the Hydro Dynamics site. The excess heat persists with no explanation and no obvious fault in the calculations. Is this an excess heat device, and does it have anything to do with "cold fusion"? We'll let our astute readers be the judges.

Report by Jed Rothwell on a site visit

On January 5 and 6, 1994, Eugene Mallove and I visited James L. Griggs and his associates at Hydro Dynamics, Inc. in Cartersville, Georgia. The company is located less than an hour's drive north of Atlanta. We witnessed a series of experiments with the company's "Hydrosonic™"pump. This is a brief report of what we saw.

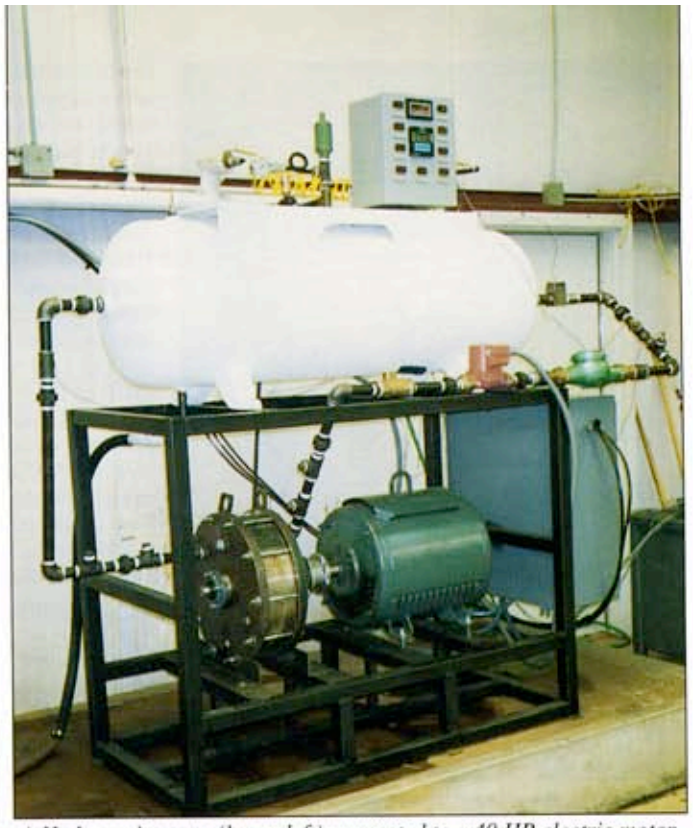
Background

The Hydrosonic Pump is claimed to be an excess energy device that physically resembles a pump in many ways. It appears to produce massive amounts of unexplained excess energy, perhaps by generating ultrasound, which creates bubbles in the water at the surface of the device's metal components. This process may be similar to the Stringham [1] "microfusion" device, except this machine employs ordinary water, not heavy water. Whatever causes this apparent excess energy, I suspect it may be related to light water cold fusion energy generation. It does appear to produce massive amounts (multi-kilowatts) of heat energy reliably, on demand, for prolonged periods, so it is clearly an interesting process that was worth investigating. The device is described in detail in Hydro Dynamics, Inc. sales literature and in a U.S. patent. [2] Griggs described his work at the Fourth International Conference on Cold Fusion (ICCF4). [3]

I will not describe the Hydrosonic pump here in detail, but I would like to clear up one issue that has confused many who have heard about it. This device is called a "pump" for lack of a better word. It does not actually move the water very much; "pump" is something of a misnomer, "stirrer" would be more accurate. It is a kind of rotor with holes drilled around the circumference of the rotor; when the rotor rotates very rapidly, these holes apparently create ultrasonic waves, which in turn somehow cause the effect. Because the device is not actually a pump, a small auxiliary pump (consuming a small fraction of a horsepower) moves the water from a feedwater tank, through the pipes, into the Hydrosonic pump, and out through a steam pipe or separate steam and condensate pipes. The pump heats the water by the stirring action, but under some circumstances it also seems to create considerably more heat than a motor driving a stirrer would.

This device is much larger than any other "cold fusion" device that I have ever witnessed or heard about, and it looks far more practical. During one of demonstrations we watched, over a 20 minute period, 4.80 KWH (kilowatt-hours) of electrical energy was input, and 19,050 BTUs of heat evolved, which equals 5.58 KWH, 117 percent of input. The actual input to output ratio was even better than this, when you take into account the inefficiencies of the electric motor.

I have been to Hydro Dynamics, Inc. on three previous occasions, and Mallove was there once. We have been generally impressed, but there have been some inexplicable failures, and they made an embarrassing mistake with some untested, improperly calibrated thermocouples. On November 22, 1993 however, I observed a very impressive demonstration, which I described to some correspondents. [4] In this experiment, a 55-gallon steel drum filled with 200 lbs of water was used to capture steam and condensate. Both the water in the tank and the feedwater going into the device start out at room temperature, so the final mass and Delta-T temperature increase in the water in the steel drum can be used to estimate the lower limit of the enthalpy (total energy) generated by the pump. This is a lower bound estimate because a large amount of heat is lost from the pump, pipes, and steel drum by radiation during the course of the experimental runs, which last from 15 minutes to an hour.



A Hydrosonic pump (lower left) connected to a 40 HP electric motor. White water holding tank is used in some hot water heating tests.

The experiments we saw on January 6, 1994 were far more impressive than anything either of us previously witnessed.

Test Procedures and instrumentation

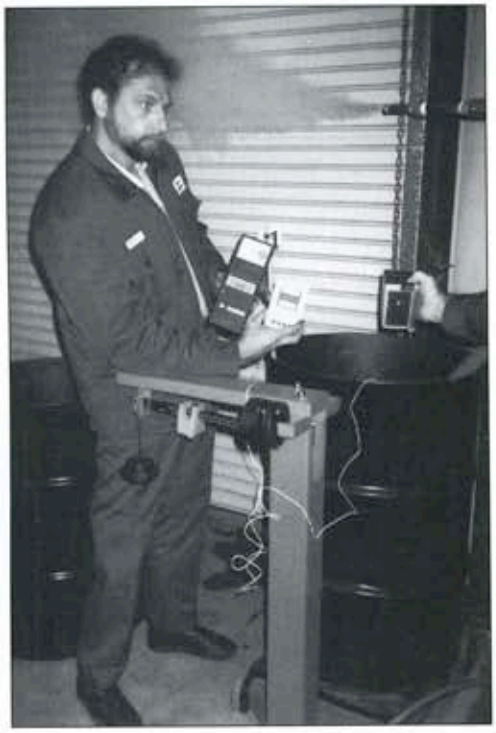
The procedures and instrumentation used in these tests were similar to those I described in the November 22, 1993 document [4], so I will not repeat them in this report, except to note a few improvements:

This was a test of steam-production only, not of hot water, or of mixed hot water and steam.

The flow rate and total amount of water consumed in these tests is much smaller than with the hot water and mixed hot water and steam tests. This makes the experiment much easier.

A large clear plastic bucket (or possibly Tupperware) has been added to the top of the input feedwater tank. This serves as a hopper. It is marked in two scales: tenth-gal-

Inventor James L. Griggs releases a blast of steam into the test facility from an operating Hydrosonic pump. (Photos by E. Mallove and J. Rothwell)



The 55-gallon barrel used to condense the steam in an initial 350 pounds of water rests on a calibrated weighing scale. Phil Griggs displays multiple temperature probes used in this simple calorimetric test.

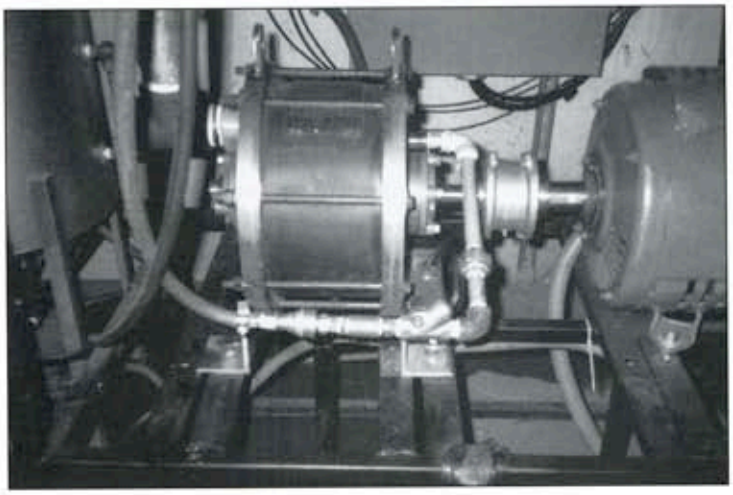
lons and pounds, up to one gallon. Water is added in eight pound increments from a marked plastic milk bottle. (Eight pounds is nearly one U.S. gallon). Care is taken to ensure that there are no air bubbles in the feedwater tank. This makes it much easier to record the flow and total water consumed. The hopper is topped off to eight pounds at the beginning of the run, and the amount added during the run is recorded. The total amount consumed is compared to the weight increase in the steel capture drum, and the numbers match closely, to within two or three pounds, proving that most of the steam is condensed and captured.

A new flow control with integrated flowmeter has been installed to accommodate the low flow rate. The flowmeter is reasonably accurate but it is marked in large increments. It is much easier to use a stopwatch to measure the time it takes for the water to drop in the hopper.

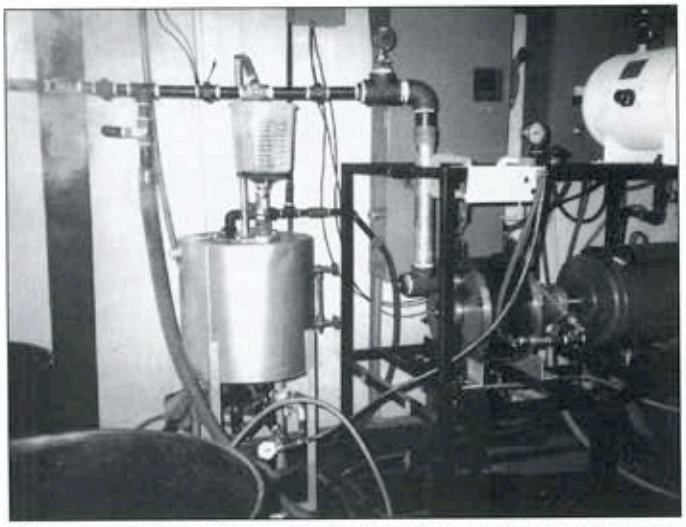
Because the flow in this steam test is so much smaller than in a hot water or mixed steam and hot water test, the steel drum can be filled with much more water to start with; 350 pounds versus 200 pounds in the previous experiments. The 350 pounds is enough to condense virtually all of the steam, as long as the output hose is held down at the bottom of the drum. Another great advantage of this is that the water temperature does not rise much in a given period of time, so that heat losses are smaller, the temperature is easier to measure, and the steel drum is safer to be around, with less danger of scalding.

Temperature measurement, as before, was done with two or three electronic thermometers, which agreed to within 1° F, and one Taylor cooking thermometer, marked in five-degree increments, which agreed closely with the electronic thermometers. The Micronta thermometer began to malfunction towards the end, jumping from 60 to 90 down to 40 , probably because of a weak battery. This event proves yet again the wisdom of these experimental techniques and rules: use multiple instruments; use simple rough-and-ready backups to do "reality tests"; keep an eye on things at all times—and use common sense. Dennis Cravens [5] and I are both strong advocates and proselytizers of these principles, and Griggs personifies them.

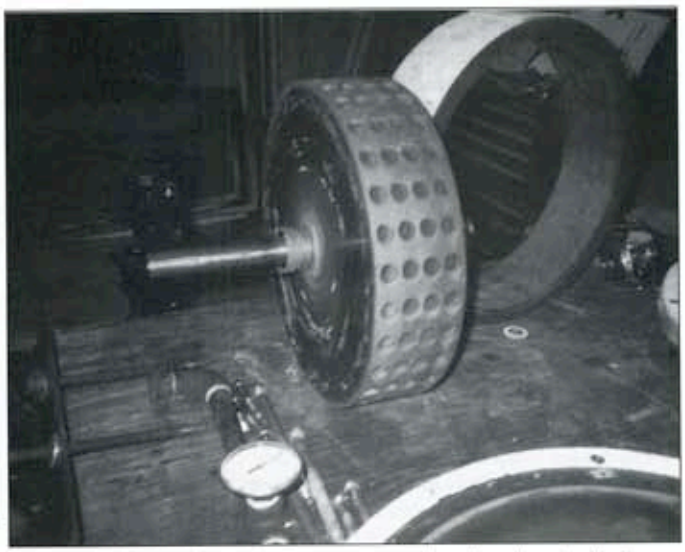
In these tests, only one power meter was used: a General Electric Dranetz model, which was calibrated by G.E. on October 5, 1993. This is an expensive digital power meter, which is suitable for measuring the power consumption of a three-phase alternating current-powered electric motor such as used in these experiments. In previous tests, the Dranetz compared within one percent to the BMI 3030 instrument that was used in parallel; the Dranetz manual says it is accurate to within 2 percent at full load. Full load is 200 KW (kilowatts), much higher than these



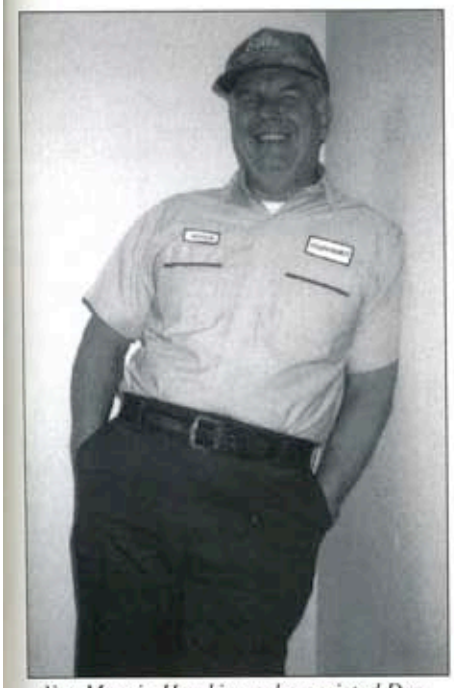
Close-up showing motor coupling to pump, water feed line entering at right, and steam exit pipe on left.



The steam test system described in the article. A Hydrosonic pump venting steam into the room reaches a steady operating condition. Plastic water feed reservoir is above cylindrical water holding tank.



Disassembled Hydrosonic pump rotor and casing, showing holes on rotor periphery that appear to be key to the heat production.



Not Marvin Hawkins, who assisted Drs. Pons and Fleischmann, but Marvin Dawkins, who works at Hydro Dynamics!

The weight scale was checked on November 16, 1993, by a Georgia Tech team, which also came to investigate. They brought iron weights, which they had checked on accurate scale at Tech, and they determined that the Hydro Dynamics scale is correct through the full range of its rated capacity, up to 1,000 lbs. On January 7, Gene Mallove and I both checked the calibration of the scale by standing on it. We did not, however, attempt to calibrate the scale while standing on it, a false calibration technique similar to those pioneered by others in this field [6]! The scale registered anomalous increases in body weight probably due to Christmas Season overeating. Other scales show the same numbers to within 1 lb.

January 6 tests

We witnessed three experimental runs on January 6, 1994, one in the morning and two that afternoon.

Test 1. A 1-hour blank run that generated little or no excess heat. The Hydrosonic pump water flow input rate and visually observed (through a glass window) level of water within the pump was deliberately set to a condition that had previously evidenced no excess energy. When the pump is too full, or some other operating parameter is not right, the pump generates exactly as much heat as you would expect any other stirring device to generate; exactly like the classic experiments of J.P. Joule. But, when the correct flow and pressures are achieved, the effect turns on, and this fact is easy to observe. The flow rate of water going in remains constant, and the cloud of steam coming remains the same, but the electric power draw drops dramatically, by 20 percent to 50 percent, say from 23 to 14 KW.

Test 2. A 19-minute excess heat run.

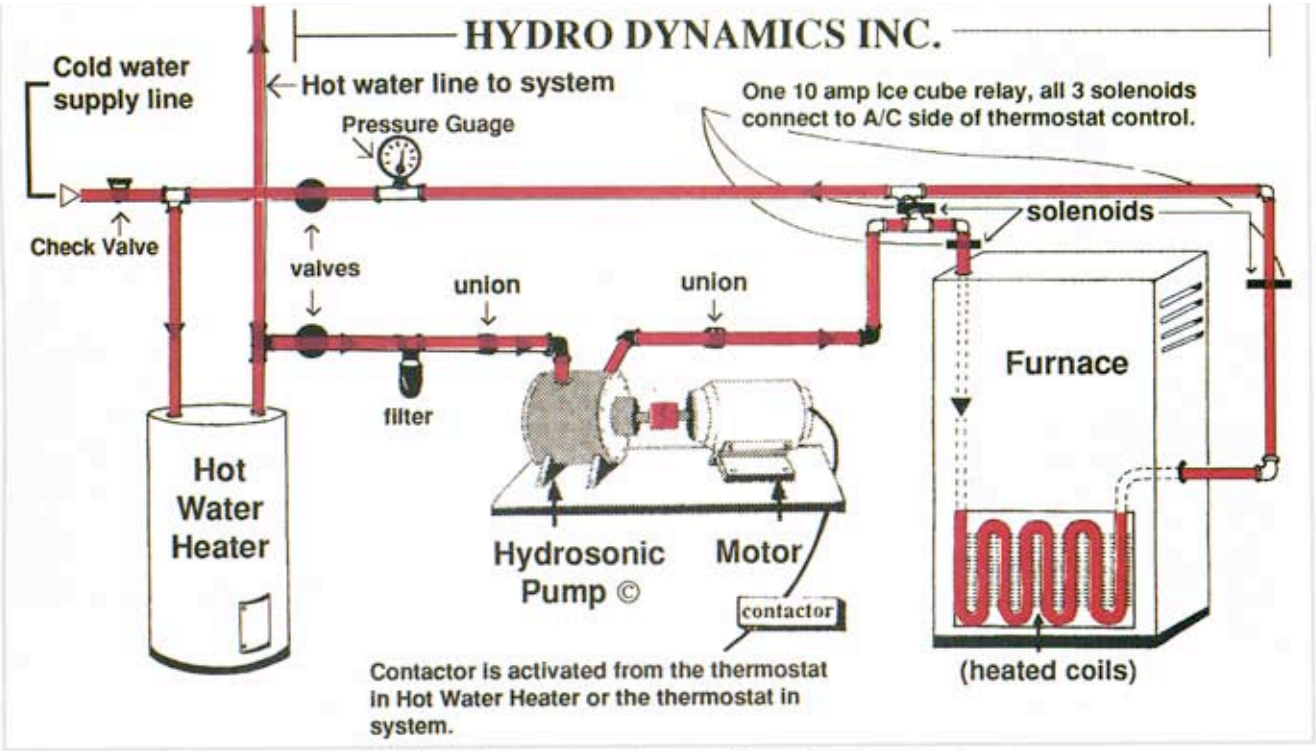
Test 3. A 30-minute excess heat run with flow rate, pressure and other parameters adjusted as closely to Test 2 as possible, which generated nearly the same amount of excess heat per minute.

These tests showed that Griggs has considerable control over the reaction. He can start it and stop it on demand, even though he says he does not understand the underlying cause of the reaction.

Some considerations regarding input power computation

As mentioned above, the Hydrosonic pump is a kind of rotor device. It is turned by an industrial three-phase AC electric motor. The motor turns a shaft, the shaft turns the pump device at several thousand RPM, the pump heats up the water because of ordinary fluid friction, and additional heat comes from the mysterious process. There are two important factors which should be kept in mind when evaluating the input power in these experiments:

1. An electric motor works most efficiently at the peak ratings for which it was designed. When an electric motor runs at a much lower load than for which it was designed, the difference between Apparent Power (volts times amps) and "True Power" becomes large. The ratio of True Power divided by Apparent power is known as the Power Factor (PF). This is described in many introductory texts on AC power. [7] The PF is computed automatically by the digital Dranetz power meter used in these experiments, and an average PF for the run is displayed, although the meter computes the instantaneous PF at all times.



Schematic of Hydrosonic pump system integrated into existing home heating system.

In these tests, a 40 HP motor was used to drive a relatively small, 12-inch diameter rotor, so the PF was lower than other tests I have observed, varying from 73 percent up to 84 percent. A 30 HP motor would be more appropriate for this pump, it would have yielded a higher PF.

2. All electric motors suffer some degree of mechanical power loss. Conversion from electricity to rotary motion cannot be 100 percent efficient. The motor used in this test is rated at 82.5 percent nominal efficiency by the manufacturer. It is likely that the actually efficiency is somewhat less than this. Energy lost in the conversion appears in the form of waste heat that stems from the metal laminations in the field windings. The casings and innards of motors of this size get very hot; they are equipped with blowers to keep them from overheating.

Tests 2 and 3 showed excess heat even when compared to the unadjusted Apparent Power. In Test 2, The Coefficient of Production (C.O.P.) was about 117 percent measured against the Apparent Power. However, if we take into account the relatively low PF (caused by the inefficiency of this large motor driving the small pump), and the energy lost in conversion to mechanical, rotary motion, the C.O.P. was closer to 170 percent, that is, the input to output ratio was roughly 1:1.7. A great deal of other energy was not accounted for, in readily apparent losses like thermal radiation from the pump, which is the size of a small automobile engine block, and which was over 300° F during the run. The 117 percent C.O.P. is the most conservative, lower bound estimate possible. This fact was demonstrated by Test 1, the null run. In this test, the lower bound C.O.P., comparing to Apparent Power, was 59 percent. Adjusted for PF and mechanical losses, the C.O.P. was 98 percent, very close to a balance of input and output.

The performance window

Griggs has explained and demonstrated the fact that his machines have a window of performance, defined by a set of flow rates, pressure, rotation rate, and so on. If you operate one of the machines below or above the performance window of that particular machine, it will produce little or no excess heat. He demonstrated this fact.

The pump used in these experiments was a new, experimental design, optimized to create steam, rather than hot water. He had not finished working out the range of operating parameters for it. This particular machine, unfortunately, suffers from a rather narrow window of performance. It works best with a flow rate between 0.15 and 0.25 gallons per minute, and for reasons he has not yet determined, it requires a relatively high input pressure. It is much more difficult to adjust than some of his previous models, but it has a high C.O.P. and it produces pure steam without a mixture of unboiled water. He expects to fix the narrow performance window requiring the finicky adjustments with a new pump which will be ready in a few weeks.

During the demonstrations, he had difficulty getting the machine to balance input water and output steam rates properly, and he had trouble keeping the flow high enough to do that. He demonstrated what happens when the flow is too low; the water in the narrow compartment around the spinning rotor suddenly drains off in what he calls "deloading"—an explosive burst of steam. The motor then spins freely, and the power draw drops to about 4 KW, the level you see when the pump is run without water. It is surprisingly difficult to fill up this experimental unit after this happens; you have to shut the output valve, fill it up, and gradually open. This pump was equipped with a thick glass porthole at the end of the outer bearing (the side away from the motor), allowing a view of the water sloshing around inside, which allows you to gage the water level in the pump. Getting the input and output flow to balance is a little bit like trying to adjust a hose so that it will fill a bucket with a hole in its bottom up to a certain level, and no higher. However, once you get everything in balance, the machines tend to stay in balance for extended periods of time. An actual operating pump at a customer site is equipped with preset flow control and pressure control valves. Most operating pumps are bigger and they have wider "windows," for example, an ideal flow might be between 5 and 7 gallons per minute, which is much easier to ensure than the 0.15 and 0.25 of this experimental unit.

Again, when the pump is too full, or some other "window" operating parameter is not right, the pump generates exactly as much heat as you would expect any other stirring device to generate; exactly like the classic experiments of J.P. Joule. But, when the correct flow and pressures are achieved, the effect turns on, and this fact is easy to observe. The flow rate of water going in remains constant, and the cloud of steam coming re-

mains the same, but the electric power draw drops dramatically, by 20 percent to 50 percent, say from 23 to 14 KW. The sound the machine makes also changes noticeably. Sometimes the drop in power draw will fluctuate around, as the effect fades in and out, but it will soon stabilize and the machine will go on producing the same amount of steam as it did before, with far less electricity than it used previously, for hours, or days.

When the machine is not producing any excess heat, the power draw (in kilowatts) numbers on the Dranetz are proportional to the flow, increasing as the input flow valve is opened, decreasing as it is shut, just as you would expect. When the excess heat effect turns on, input power no longer changes as much in response to flow adjustments.

Results

TEST 1 January 6, 1994 11:30 a.m.

When we arrived, Griggs explained to me that he was having trouble boosting the flow rate and maintaining pressure on the unit, so he was not getting a measurable effect. However, he had managed to balance input and output, and to bring the machine into a steady state, so we decided to let it run for an hour producing little or no excess heat, as a "blank" or null run test of the calorimetry. The flow rate was below the window, at 0.05 gallons per minute.

Results were as follows:

Starting mass and temperature of water in steel drum: 350 pounds, 55° F. Water in input hopper also 55° F.

Ending mass and temperature in steel drum: 376 pounds, 127° F

Water temperature Delta-T: 72° F

Energy added to water: 72° F x 376 pounds = 27,072 BTUs, which equals 7.93 KWH.

It is important to remember that all of the water that ended up in the steel drum was tap water starting at 55° F. Ambient temperature was slightly higher, at 63° F, but this large mass of water could not absorb any significant amount of heat from ambient in spite of the 8° F difference, because it was heated by the pump above ambient 6° F only minutes into the test.

Dranetz input power: 13.46 KWH, Dranetz PF: 73%

C.O.P. computations (C.O.P. is output energy divided by input expressed as a percentage)

	Input KWH	C.O.P.
Apparent	13.46	59%
Adjusted for PF	9.83	81%
Adjusted for PF and motor efficiency	8.12	98%

Conclusion: This is close to a balance of input and output. Because there must have been significant radiant losses, if there were no excess heat at all, I expect the C.O.P. would be lower than 98 percent, so these results might indicate a small effect.

TEST 2—January 6, 1994, 3:00 p.m.

In the afternoon, after the machine turned on and warmed up for 5 or 10 minutes, Griggs and the others tinkered with the input and output flow valves and some other parameters, and after about 20 minutes in all, they announced that the flow was steady at 0.20 gallons per minute, and the power draw in kilowatts had fallen, so the effect was turned on. The valve venting the steam outside was shut, the valve leading into the steel drum was opened, and we collected the steam for 19 minutes, 40 seconds. The run was terminated when a circuit breaker in another part of the building shut down the controls. The main power feed did not fail, but it is held on by solenoid actuators, which opened up. The recording Dranetz meter has a battery back up, so no data was lost. All other data collection is by stopwatch and pen on paper. (Events like this remind us that sometimes, the old, simple ways of doing science are the best ways.)

Results were as follows:

Starting mass and temperature of water in steel drum: 350 pounds, 53° F. Ending mass and temperature in steel drum: 381 pounds, 103° F

Water temperature Delta-T: 50° F

Energy added to water: 50° F x 381 lbs = 19,050 BTUs, which equals 5.58 KWH

Dranetz input power: 4.80 KWH, Dranetz PF: 84%

C.O.P. computation:

	Input KWH	C.O.P.
Apparent	4.80	117%
Adjusted for PF	4.03	138%
Adjusted for PF and motor efficiency	3.30	168%

Conclusion: Excess heat was detected at levels far beyond any reasonable error limits for the instrumentation used. If the equipment had been performing the same as it did in Test 1, the final water temperature would have been closer to 80° F than 103° F. This is computed as follows: 4.80 KWH Apparent is delivered to motor, adjusted for PF and efficiency, would have created 3.33 KWH of heat, which equals 11,372 BTUs, which would have raised the 381 pounds of water by 30° F, but it went up 50° F, instead. I am certain that even my kitchen cooking thermometer can detect the difference between 80° F and 103° F.

This test ran for one-third the time of Test 1. The flow rate was 0.20 gallons per minute, compared to 0.05 g.p.m. in Test 1. The improved PF was because the motor was carrying a greater load with the greater flow rate.

TEST 3 4:04 p.m.

Test 3 ran normally for 30 minutes.

Results were as follows:

Starting mass and temperature of water in steel drum: 350 pounds, 53° F. Ending mass and temperature in steel drum: 392 pounds, 122° F

Water temperature Delta-T: 69° F

Energy added to water: 69° F x 392 lbs = 27,048 BTUs, which equals 7.92 KWH.

Dranetz input power: 7.26 KWH, Dranetz PF: 84%

C.O.P. computation:

	Input KWH	C.O.P.
Apparent	7.26	109%
Adjusted for PF	6.10	130%
Adjusted for PF and motor efficiency	5.03	157%

Conclusion: Nearly as much heat as Test 2. Again, the results appear to be far above any possible experimental error.

References

1. R. Stringham, "Cavitation Induced Micro-Fusion," Fourth International Conference on Cold Fusion (ICCF4) paper C 3.9

2. J. Griggs, U.S. Patent Number 5,188,090, Feb 23, 1993, "Apparatus for heating fluids."

3. J. Griggs, "A Brief Introduction to the Hydrosonic Pump and the Associated 'Excess Energy' Phenomenon," ICCF4 unnumbered paper. This will appear in the full ICCF4 (Fourth International Conference on Cold Fusion) Proceedings in 1994; it is already available from HydroDynamics, Inc.

4. J. Rothwell, "Brief Report on the November 22, 1993 Demonstration of the Griggs Device," Cold Fusion Research Advocates.

5. D. Cravens, "Factors Affecting the Success Rate of Heat Generation in CF Cells," ICCF4 paper C 3.12

6. N.S. Lewis, et al., *Nature*, 340, 525 (1989)

7. V. Valkenburgh, "Basic Electricity, Revised Edition," Hayden Books, p. 4-44–4-48.

Implications

Clearly the story of the Hydrosonic pump may be just beginning, if further testing makes its apparent multi-kilowatt excess heat production more certain. It is difficult to imagine how there could be a measurement error of the output heat. If anything, the output end measurement is very conservative in that it discounts the waste heat that escapes from the collecting barrel and piping. Several groups, including these authors, have suggested that a dynamometer be applied to measure the actual mechanical input power to the rotor, rather than relying on electrical measurements on the motor. If dynamometer measurements confirm the general efficiency estimate for electrical-to-mechanical conversion, the case for over-unity performance would be pretty iron-clad. Then we would be faced with two major questions: 1. What physical mechanism within the metal and water is causing the excess heat? and 2. Can the performance of the device be increased to make it stand alone, perhaps making it self-powering or self-sustaining once started? James Griggs told us that earlier versions of the Hydrosonic pump that were smaller and less amenable to disassembly for repair occasionally evidenced even higher C.O.P.s—2.0 and above!—than those measured with the recent larger units. CF