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A Tribute to GENE MALLOVE – THE "GENIE" REACTOR

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ABSTRACT

"Genie", a 40 KHZ sonofusion reactor consists of 2 opposing 40 KHz piezos separated by 4 mm of D_2O, with a centered Ti target foil, with one piezo transmitting, the other receiving and taking that signal, amplifying it, then feeding it back to the transmitter as the resonating frequency of the reactor. This process makes for efficient watt input, Qi, where 80% of these watts will be used as the acoustic input, Qa, to the "Genie" sonofusion reactor. In the reactor the transient cavitation bubbles, TCBs, produce billions of low energy high density jets per second that accelerate deuterons into foil targets producing excess heat, Qx. The Qx is determined by calorimetric measurements of experiments that use coolant water circulated to the surface of the well insulated reactor and data collected in the form of T in and T out at steadystate temperatures and coolant flow rate. The total watts out, Qo, minus Qa ideally should equal zero, and we know that this calorimetry method has several losses that are not measured. This makes the method very conservative when looking for Qx. The Qx must make up those heat losses before making its presence known. The result from experiments of system I using flow x DT x 4.184 for Qo – Qi = Qx shows that Qx values over unity are the norm. System II used a more realistic calculation for Qx where flow x DT x 4.184 for Qo – Qa = Qx showed increased results. The calibration of the reactor with a Joule heater, JH, and substituting H_2O for D_2O produced measurements that showed the reactor calorimetry was close to zero Qx production as one would expect. These measurements showed that heat in = heat out, a good zero indicating no Qx, for the operation of the "Genie" sonofusion reactor.

INTRODUCTION

Gene Mallove would be pleased to know that his work and the work at NERL laboratory, NH produced a cavitation fusion device with reproducible excess heat capabilities after a few modifications. Even better, a sonofusion device produced Qo (the heat out) in an amount that exceeds Qi (the total heat input). The original work on this device came to a close because of a shortage of money and time. The NERL laboratory reactor was sent to SRI for testing where problems developed with D_2O and Ar leakage and therefore was not suitable for testing. The abandoned device was purchased from Gene Mallove by Kip Wallace, my brother- in-law, who was present during the device testing at SRI and Kip proceeded to modify the device. The two major modifications were making the reactor capable of operating at 6 atm. of Ar pressure without leaking and a feedback oscillator based on the natural resonance of the reactor. Kip brought the modified device to First Gate's Laboratory in Hawaii for calorimetry measurements, which showed positive Qx, excess heat. The initial input from Gene Mallove, Ken Rauen, Jan Roos, Chris Eddy and the rest of the NERL lab with some more time and thought supplied by Kip Wallace resulted in experiments that produced positive Qx. The original sonofusion reactor that Gene purchased from First Gate is stored with other equipment at the NERL laboratory.

The main tool for demonstrating the presence of Qx is the discovery of a system robust enough to demonstrate a sizable amount of unexplained heat coming from a fully understood system. The product for commercial use is Qx and other products such as ^{4}He, T, and other possible nuclear products that may also be of commercial value. We have such a system with conservative data showing that the "Genie" sonofusion reactor produces Qx where Qo exceeds Qi.

Calorimetry is the method for measuring the amount of heat produced by a system regardless of its source. The calorimetry that was used for this 3 Kgm sonofusion reactor with opposing 40 KHz piezos was limited to a simple methodology. We isolated the reactor in the center of an insulated box. The maximum operating steadystate temperature was 70 ºC with the heat removed from the surface of the reactor by copper coils with circulating water. The ratio of surface area of the insulation box to the reactor was 100. The coolant flow rates were varied from 0.5 to 6 ml/sec, which when multiplied by DT measurements (T out – T in) produced the Qo. To calibrate the circular reactor (a 15 cm tube with a 9 cm diameter), a long resistance Joule heater, 100 watts, was coiled at each end of the reactor. Calorimetry is always imperfect and the flaws in this methodology will show a lower Qx than generated.

The Qx of this device demonstrates an over-unity system and will show the way to others to explore cavitation that has the robust nature for future energy systems. The economics of cavitation sonofusion systems are here today. [1].

CALORIMETRY

A 30x40x40 cm Styrofoam box is filled with a polyurethane foam with the sonofusion reactor placed at the center. The circulating water flows through a 4mm diameter copper tubing that is 350 cm long and tightly coiled on the surface of the steel reactor housing. The thermocouple measurements of T in and T out provide for the DT values of this water coolant flow for the calculation of Qx. Coolant water is pumped through the circulation system by a variable FMI pump with a 0.635 cm ceramic piston. The system starting from the pump goes though a flow meter. The coolant then flows into the copper coil (T in), removing heat, and out of the coil (T out) and finally into the coolant bath heat exchanger reservoir. The flow was calibrated at regular intervals with a volume measurement over a 1 minute time period taken at the output coolant flow into an 8 liter water coolant bath. The reservoir is the recipient of the heat from the reactor. Its large volume and open surface allows for steadystate T in temperature measurements. From the reservoir the cool flow continues and completes its cycle to the pump. Note that the diurnal temperature fluctuation is only 2 ºC in the Kauai First Gate laboratory. (See fig. 1)

The flow rate has an effect on the efficiency of heat removal and on the DT that influences the Qx measurement. A low coolant flow rate provides a high DT but a low Qx and a high flow rate provides a low DT but a better Qx value. A compromise flow rate between 3 and 4 ml/sec realizing that the Qx measurement will be low but a better DT measurement is the result.

It is important that the measurements of Qo be made at steadystate temperatures and steady flow rates. This provides the only good values for DT ºC. The TC data is collected at 1 minute intervals where Qo = FxDTx4.184 watts (F is the flow rate in ml/sec) and Qo – Qi = Qx. If you want a more realistic value add Qoc, the heat lost from the oscillator (Qoc =0.2x Qi) to the Qx value (Qa = 0.8xQi) and Qi = Qos + Qa. (See fig. 2). Calorimetry data established the 20 % values of Qi that are lost to environment, Qoc.

EXPERIMENTAL

The sonofusion reactor consists of a heavy steel pipe housing with two opposing piezo stacks with Ti faces and 6 mm between the Ti piezo faces. (See fig. 2) In the volume between the faces is the reactor’s D_2O with a Ti foil suspended in the center. This is a static system as the D_2O is not flowing. At the top of the reactor is an Ar port and small pressure gauge. The reactor is sealed with “O” rings and placed at the center of an insulated box. The copper coils remove the flow of hot coolant water from the reactor to the heat exchange water bath reservoir. Another set of copper coils contains a thin wire Joule heater for calibration purposes. An FMI piston pump with variable speed control circulates the coolant, and the coolant flow is measured with a flow meter. The flow is also checked by its volumetric flow. (See fig. 3) The piezo stacks are made up 1/2 wave Ti slugs with 4 mm PZT piezo. One stack is a 40 KHz transmitter, the other a receiver – a matched pair. The electrical input to the transmitter comes from the line to a controlling variac to a wattmeter and a high voltage transformer, then to the oscillator. The oscillator is located in a box calorimeter with the high frequency (40 KHz) input going to the piezo, Qa. The other piezo stack is the receiver and picks up the reactor resonant frequency - the piezo and reactor’s primary resonance - and sends that frequency back to the oscillator to be amplified as the input signal. The advantage is a single amplitude and frequency that follows small resonance changes in the reactor as the temperature and small geometry change in the reactor. The oscillator heat production is measured and can be subtracted from Qi to give more accuracy and added value to Qx. The box is a Joule heater, JH, used to calibrate the heat loss of Qi and determine its efficiency (the loss averaged over 20 runs from the oscillator and transformer was 20%). (See fig. 2)

The D_2O was degassed and put into an Ar filled reactor. The Ar was added via a syringe port to a pressure of 5 atmospheres over the D_2O. The loaded reactor with the thermocouples in place was located at the center of the styrofoam box and filled with an expanding foam polymer. The 8 liter coolant reservoir was filled and the pump started for the circulation of coolant through the Cu coolant coils. After checking the seven TCs (40 gauge, type K) and the coolant flow rate, the power was turned on, a wait of 120 minutes before the system reached steadystate temperature, then the Qx measurements were started. The reactor was sampled every minute for data and the runs lasted about 400 minutes. The data could be checked in real time for Qx. We used an Omega 16 channel PCI-DAS-TC for the data gathering. The data was collected in a spreadsheet on a Windows 2000 PC.

DATA and INTERPRETATION

The data was collected over a six week period and was divided into SF I and SF II (sonofusion I & II). SF I did not have a Joule heater, JH, and SF II was reloaded with D_2O and Ar with the second JH installed (the first was in the SF reactor) in the Qoc calorimeter and finally reinsulated. (See fig. 1) The collected data was reduced in a spreadsheet to show variations in important parameters. (See spreadsheet) We can look at Qo and Qi of the sonocation runs of D_2O and H_2O and compare with the JH calibration runs with D_2O and H_2O. The calibration runs show no Qx. In the simplest form Qo-(Qi+Qx), heat out = heat in, and always equals 0 if the is no Qx, so Qx = Qo – Qi (SF 1). In the case where reactor JH is the energy input into D_2O and H_2O in calibration runs, the Qx should equal 0, which it does. Also in the case where there is sonication in H_2O runs, Qx is much less than with D_2O runs. This data indicates a small Qx with H_2O in sonication runs. The data in the case of sonication of D_2O shows varying degrees of Qx production. Figure 2 shows the reduced data of Qx from two slightly different reactor configurations. The SF I system runs and the SF II system runs are shown. Also shown are the JH runs that serve as a calibration for the SF runs. The data from the JH runs are treated exactly the same as the SF runs and show no Qx production.

The zero line in the graph represents Qi, the input watts, and any data above that line is a Qx production point (the error is ± 1 watt). The light line from the origin slanting down from left to right is that part of Qi that is lost as heat to the oscillator and has a value of 20% of Qi. So any point above that line is a real Qx production run (the error is ± 1 watt). The data from the SF 1 is all above the zero line which means it was over unity – more energy out than in.

In figure 3 the SF II D_2O system is producing Qx at a much higher level than in SF II H_2O which is consistent with our old data [2,3]. At 40KHz the Qx data is not truly reproducible but is consistent in the Qx effect.

DISCUSSION

The data presented shows that Qx is produced in a static 40 KHz system with no circulation of the cavitation liquid. The results are very similar to old work with the main difference being the way in which the opposing piezos are used and powered. In the old work both piezos were transmitting and used a frequency sweep through several KHz coupled with a variable voltage input [2,3]. Compare this with the input of a single resonant frequency of the “Genie” reactor amplified from the receiver piezo. The single frequency may be just off the sweet spot and the introduction of a narrow sweep may improve Qx results. The Qi efficiency of 80% for the “Genie” reactor was much higher than that of the old Mark III [2] with an efficiency of 30%. The operating temperatures for the Mark III were 100ºC and higher with similar Ar pressures. The parameters of operating temperatures, of pressures, and of Qa inputs are coupled and will have one of three outcomes. These are cavitation bubble frothing, no cavitation bubbles, and TCB production. It is the TCB production that relates the correct balance of the three parameters [2]. It appears that SF I had higher Ar pressure and with the other two parameters at about the correct magnitude, temperature and increased Qa input, produce the largest Qx. The lower Ar pressures in SF II produces a more moderate Qx production. A reactor temperature of runs in the SF II reactor system of 30ºC produced a measureable Qx and at high temperatures around 60 ºC produced no Qx. The answer may be that the cavitating D2O was frothing at 60 ºC. More work should be done in this area.

A tentative path and mechanism to Qx have been proposed by several theorists [4, 5, 6, 7] and a path has been put forward for the TCBs that depends on the tremendous transient deuteron pressures that are generated during the final stages of TCB collapse and the following deuteron lattice implantation [8].

The effect of the flow rates on the measurement of Qx was always an issue. At low-flow rates there was a large DT, which is good but DTxF was low. At the other extreme was a high flow rate with a low DT and its DTxF product was higher and closer to the real Qx. One can slowly vary the flow rate and see an asymptotic value for Qx. This is a good idea but very time consuming and we were satisfied with the lower Qx values we were measuring.

In our calculations we used two different measured relationships. One was the rate of flow measurements and the other the DT measurements. We did a volumetric measurement as well as using a flow-meter for the water circulation flow measurements. A graph of this data puts the flow data on a solid footing, although there was some error (±3 %). (See figure 3.) The second was the DT temperature measurements of the water flow in and out of the "Genie" SF reactor measured at ± 0.2 ºC. The measurement of the heat loss of the oscillator, Qos, was simple. The insertion of a TC into the oscillator's Al heat sink produced a relative oscillator temperature value for each run. These oscillator heat sink temperatures were converted into watts via a 15 watt variable JH. Both the oscillator and the JH were housed in a box calorimeter. (See the calorimetry section and figure 1)

CONCLUSION

The "Genie" sonofusion reactor produces Qx in amounts that are robust enough to overcome the shortcomings of the calorimetry measurements. The insulation was substantial and allows for the enclosed reactor to be observed as a point heat source. The reactor (small, hot, and conductive) was placed in the center of a large insulated box. The small amount heat loss from the exterior surface of the box was viewed as heat arriving from a point source in the center of the insulated box. In the reactor there was no heat perceived at the surface of the insulating box because the circulating water removed the reactor heat. The water flowing through the copper tubing at a rate around 4 ml/sec facilitated the majority of the heat removal from the reactor. As an example a DT of 1.5 ºC with a Qo around 25 watts and a Qi of 20 watts produced nominal Qx of 5 watts not considering any heat losses. The use of the two calibration Joule heaters, one for the oscillator and one for the reactor, provided the comparative rates of heat loss to verify the SF I and II data. See figure 3. The "Genie" sonofusion reactor is robust and with the calorimetry used by the NERL laboratory would give much better results than presented in this paper.

SUMMARY

The reactor consists of 3 kilograms of steel, two opposing piezos, a reactor filled with 20 ml of D_2O saturated with Ar, and a 50 gm power supply. The calorimetry involved measurements of T in and T out of a circulating water coolant that produced steadystate temperatures and flow rates. The Qi, input, was subtracted from the Qo , to give the excess heat Qx. The maximum Qx was nearly double Qi. Future improvements should focus on reducing the weight of the "Genie" to 1 Kgm along with an increase in Qx. Both can be accomplished with a redesign. This would increase the power density output of this reactor.

ACKNOWLEDGMENTS

We want to thank Gene Mallove, Ken Rauen, Jan Roos, Chris Eddy, and all the people associated with the NERL laboratory who risked a lot of resources and personal energy to make this "Genie" work. Time was the factor as there was a learning curve with the new "Genie" that was difficult to overcome. We want to thank Kip's associates who donated their time and energy to continue this project that started in the year 2000.

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GENIE Rx Data (June to August 2004)

SPREADSHEET - 40KHZ 'GENIE' SF REACTOR

Run	SF I or II JH/S D2O/H2O	Circ. H2O T out	variac Watts in Qi	watts Ex heat Qx	Coolant flow ml/sec	ºC DT Rx	watts Qo	** % of Qi Watts is Qos	Press Ar Atm.	OSC. DT
1	I, S D2O	34.0	15.0	3.0	3.1	0.9	11.7	15.0	5.6	10.0
2	I, S D2O	8.0	15.0	-10.0	3.6	0.4	6.0	16.5	5.6	11.0
3	I, S D2O	32.0	13.0	0.5	4.1	0.8	13.7	17.3	5.6	10.0
4	I, S D2O	38.0	15.0	0.5	2.8	1.3	15.2	16.5	5.6	11.0
5	I, S D2O	34.0	14.0	4.0	4.4	0.7	12.9	14.4	5.6	9.0
6	I, S D2O	58.0	11.0	8.0	4.5	1.0	18.8	18.4	5.6	9.0
7	I, S D2O	52.0	12.0	9.0	3.6	1.4	21.1	15.0	5.6	8.0
8	I, S D2O	54.0	11.0	2.5	1.5	2.0	12.6	16.3	5.6	8.0
9	I, S D2O	28.0	23.0	0.0	4.4	0.0	0.0	0.0	5.6	[--
10	II, S D2O	32.0	20.0	5.0	3.8	1.5	23.8	14.6	4.9	13.0
11	II, JH D2O	31.0	19.0	1.0	3.8	1.2	19.1		4.9	
12	II, JH D2O	33.5	18.0	1.0	1.8	2.6	19.6		4.9	
13	II, S D2O	33.0	18.5	0.0	1.8	2.4	18.1	15.8	4.9	13.0
14	II, S D2O	33.0	20.0	4.0	4.6	1.3	25.0	15.7	4.9	14.0
15	II, S D2O	60.0	18.0	-3.0	3.6	1.0	15.1	15.0	4.6	12.0
16	II, JH D2C	29.0	10.0	0.5	3.1	0.8	10.4		4.4	
17	II, JH D2C	33.0	28.0	1.0	3.0	2.4	30.1		4.4	
18	II, S D2O	33.0	20.5	1.0	2.8	1.8	21.1	16.4	4.4	15.0
19	II, S D2O	60.0	20.0	-6.0	3.5	0.9	13.2	15.7	4.4	14.0
20	II, JH D2C	61.0	12.0	-7.0	3.8	0.4	5.5	0.0	4.4	
21	II, JH D2C	65.0	38.0	-7.0	3.8	2.0	31.8	0.0	4.4	
22	II, S D2O	34.0	20.5	0.5	3.4	1.4	20.5	16.4	7.0	15.0
23	II, JH D2O	33.0	21.0	0.0	3.3	1.6	21.8		7.0	
24	II, S D2O	33.0	21.0	-0.5	3.7	1.3	20.1	17.1	7.0	16.0
25	II, S D2O	35.0	21.0	-2.5	1.1	4.0	18.4	16.0	7.0	15.0
26	II, S D2O	38.0	21.0	-4.0	0.6	7.6	17.5	16.0	7.0	15.0
27	II, JH D2O	30.0	22.0	-3.0	0.6	8.3	19.1		7.0	
28	II, S D2O	34.0	20.5	0.5	3.4	1.4	20.5	16.4	7.0	15.0
29	II, JH D2O	33.0	21.0	0.0	3.3	1.6	21.8		7.0	
30	II, S D2O	33.0	21.0	-0.5	3.7	1.3	20.1	17.1	7.0	16.0
31	II, S D2O	35.0	21.0	-2.5	1.1	4.0	18.4	16.0	7.0	15.0
32	II, S D2O	38.0	21.0	-4.0	0.6	7.6	17.5	16.0	7.0	15.0
33	II, JH D2O	30.0	22.0	-3.0	0.6	8.3	19.1		7.0	
34	II, S D2O	53.0	20.5	-4.0	0.5	7.3	16.2	12.0	5.8	11.0
35	II, JH D2O	59.0	20.5	-6.0	3.9	0.9	14.7		5.8	
36	II, JH D2O	59.0	20.5	-9.0	2.7	1.1	12.4		5.8	
37	II, S D2O	58.0	20.0	-6.0	3.4	1.0	14.2	14.6	5.8	13.0
38	II, S D2O	33.0	22.0	-1.5	2.6	1.8	19.8	15.3	5.2	15.0
39	II, JH D2O	33.0	21.5	-0.5	3.0	1.3	15.8		5.2	
40	II, JH D2O	28.0	20.5	-0.5	3.7	1.3	19.4		5.2	
41	II, S D2O	31.0	10.5	-1.0	3.3	0.8	10.2	17.1	5.2	8.0
42	II, S D2O	30.0	6.0	-1.0	3.2	0.4	5.3	18.7	5.2	5.0

SPREADSHEET - continued

43	II, S D2O	29.0	2.7	-0.5	3.1	0.3	3.2	29.1	5.2	3.5
44	II, S D2O	28.0	0.0	-0.5	3.2	0.0	0.0		5.2	
45	II, JH D2O	31.0	10.5	-0.5	2.9	0.8	9.5		5.2	
46	II, JH D2O	30.0	5.5	0.0	2.9	0.5	5.5		5.2	
47	II, JH D2O	29.0	3.0	0.0	2.9	0.3	3.0		5.2	
48	II, JH D2O	28.0	0.0	0.5	2.9	0.5	6.2		5.2	
49	II, JH D2O	32.0	22.0	-1.0	2.9	1.8	21.2		5.2	
50	II, S D2O	33.0	19.5	-2.0	3.0	1.5	17.9	16.1	5.2	14.0
51	II, S H2O	33.0	21.5	-1.5	3.2	1.5	19.9	13.6	5.0	13.0
52	II, JH H2O	29.0	22.0	-1.0	3.2	1.5	20.1		5.0	
53	II, S H2O	32.0	10.0	-1.5	3.0	0.7	8.8	15.7	5.0	7.0
54	II, JH H2O	29.0	38.0	0.0	3.0	2.7	33.9		5.0	
55	II, JH H2O	29.0	28.0	0.0	3.1	2.2	28.5		5.0	
56	II, JH H2O	37.0	21.0	-1.0	3.1	1.6	20.1		5.0	
57	II, JH H2O	35.0	11.5	-1.0	3.1	0.8	10.4		5.0	
58	II, S H2O	59.0	22.0	-5.0	3.2	1.3	17.4	13.3	4.8	13.0
59	II, JH H2O	58.0	21.5	-3.5	3.0	1.3	16.3		4.8	
60	II, S H2O	33.0	21.5	-2.5	2.8	1.6	18.9	14.6	4.8	14.0
61	II, JH H2O	32.0	22.0	-1.0	2.8	1.8	21.1		4.8	

1) Run number.
2) Series num., sonication or JH calibration, cavitation media.
3) Circulation coolant temperature out of the reactor cooling coils.
4) The watts of electric input.
5) The watts of excess heat produced.
6) The flow rate of the coolant.
7) The coolant DT, Tout – Tin ºC.
8) The total watts output of the reactor.
9) The percent of Qi watts that is lost from the oscillator.
10) The pressure in atmospheres.
11) The calorimetry DT of the oscillator.

Figure 1 THE EXPERIMENTAL SET-UP

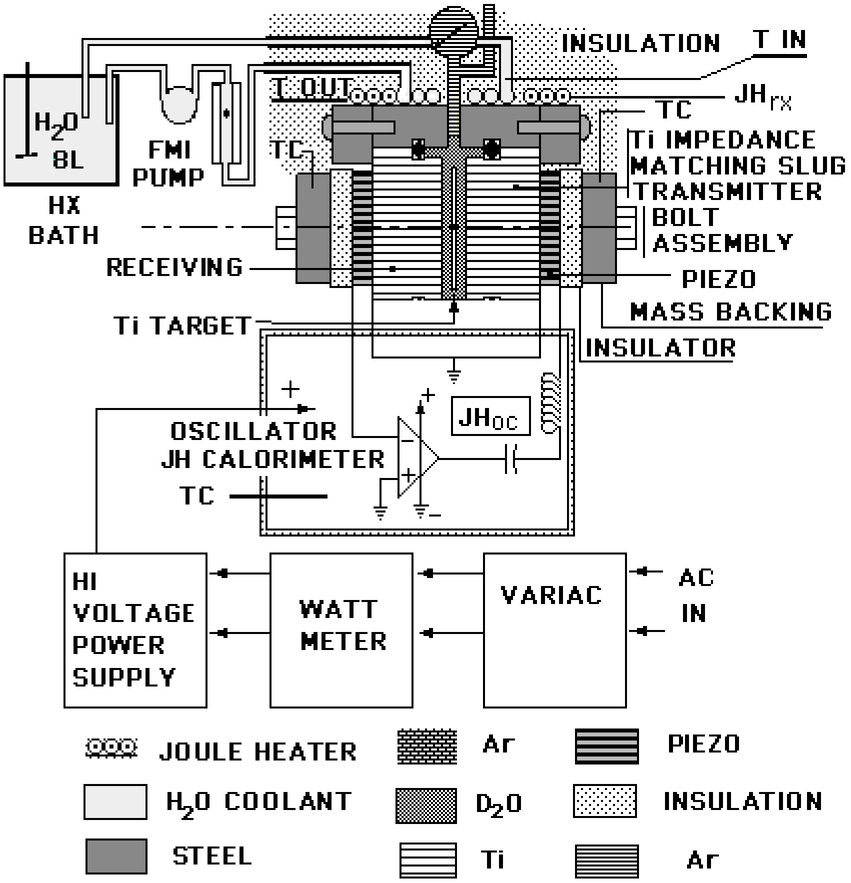

Figure 1 shows the Genie reactor in its operating mode. The insulated 3 Kgm cylindrical steel reactor where TCs measure the steadystate reactor DT and where the partitioned Qi, gives Qa, the oscillator's input to the transmitter piezo. The transmitter signal is picked up by the receiver stack which is amplified for the 40 KHz transmitting piezo output. The system resonates at its feedback resonance. The 8 liters of coolant water is circulated with an FMI pump while the reactor is powered by the sonicator or JH, Qi, as data is collected. The reactor is sealed to hold the 7 atmospheres of Ar. The 15 cc of D_2O holds a target of Ti about 50 cm^2 surface area. The insulation about 15 cm thick is polyurethane foam and there is no perceptible temperature change from the outside surface of the reactor at steadystate temperature. The oscillator is in its calorimeter with its JH calibrator to measure the Qi's partition into Qa. The Qo is found from F*DT*k.

Figure 2 THE REDUCED DATA FOR Qx DETERMINATION

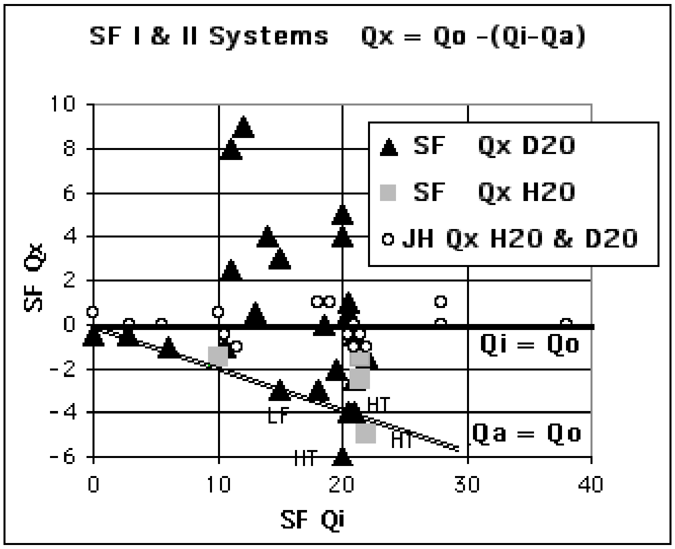

Figure 2 shows the measurement of Qx in four different systems. Two using Joule heater calibration inputs with data points clustered around the zero line for JH (open circles). The other two using acoustic inputs with data points that are above the Qa = Qo zero line for the sonication input. Those data points that are on or below the zero line are high temperature runs or low flow runs (HT or LF).

Figure 3 THE COOLANT FLOW CALIBRATION

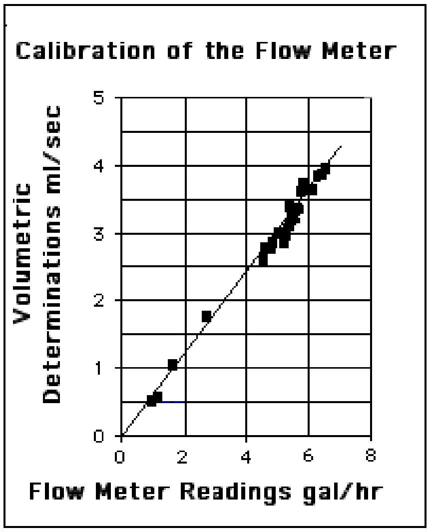

Figure 3 shows the flowmeter reading versus the volumetric measurement for each run.