FRIGI-TECH OIL SUPPLEMENT TEST

GAMMA BIOLOGICALS, INC.
3700 MANGUM ROAD
HOUSTON, TEXAS

performed by:

ADAMS MECHANICAL SERVICES, INC.
235 CORTLANDT
HOUSTON, TEXAS

TEST DATES:

JUNE 16, 1989 - SEPTEMBER 10, 1989

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Gamma Biologicals, Inc. manufacturers and sells a wide range of highly refined and specialized testing products known as diagnostic reagents. Additionally, the company manufactures and sells automated instruments that perform routine repetitive blood banking procedures.

The reagents are used to test blood to ensure safe transfusions; to detect hemolytic disease of the newborn; to determine the presence or absence of the Rh factor; to study inherited blood factors; and to aid in the diagnosis of certain human diseases.

Gamma markets its products to hospitals, blood banks, medical laboratories, physicians' offices and research institutions through a direct sales force, a dealer network and an export subsidiary. Gamma distributes its products to more than 60 countries.

Physical-plant:

This Gamma Biologicals, Inc. building contains approximately 50,000 square feet of air-conditioned space. This space consists of various laboratory facilities, production areas, corporate offices, warehouse, and a small animal housing facility.

The building utilizes 128 McQuay fan and coil units containing 6 row chilled water coils and 2 row hot water coils. The units are located above the ceiling to supply air to individual rooms. The warehouse and animal housing facility are serviced by 3 central station air handlers. All units are equipped with pneumatic controls, including thermostats and humidistats to maintain space temperatures at 73oF and relative humidity below 60%, with reheat control.

The chilled and hot water generating equipment is located in two outdoor courtyard areas. The chilled water is produced by 3 packaged air cooled chillers with a nominal tonnage of 310 tons. The equipment model numbers are Trane CGAA-120-R. Trane CGAA-100-R, and Carrier 30GBO90. Each chiller is equipped with a pump and all are piped in parallel. The hot water is generated by 2 outdoor, packaged, hot water boilers also piped in parallel.

The fan and coil units employ both two-way and three-way control valves. In addition a pressure control loop valve connects the supply and return water lines. This causes the water pumps to operate under

fixed head conditions and constant flow conditions.

This is a high energy usage building similar to hospitals, research laboratories and clean room production facilities. The owners have recognized this high cost exposure and have demonstrated active interest in reducing their energy costs. For instance:

1.Motion detectors are used to automatically turn off the lights whenever a room is unoccupied.

2.A Btu system has been installed to measure flow and temperature differential in the main chilled water circuits and use this information to optimize the chiller-pump combinations for a particular building load requirement.

3.Offsite monitoring systems have been installed to provide energy management by prescheduled, start-stop of major equipment items.

In June 1989, Mr. Michael Gebott, General Manager of Systems Operation, Mr. Charles McCleary, Director of Plant Operations and Mr. Lee Barr, General Manager of Gamma Plastics contracted with Adams Mechanical Services to conduct an inplant Field Test of Frigi-Tech Refrigerant Oil Additive. This test is described in the following documents, entitled FRIGI-TECH TESTS, GAMMA BIOLOGICALS, INC.

FRIGI-TECH TESTS

GAMMA BIOLOGICALS, INC.

Test - Preparation:

The nominal 100 ton Trane chiller was selected for testing based upon its dual compressor design. This allowed the chiller to run throughout the test and to unload at minimum load conditions without danger of freezing the chiller. The 2 condenser fans were set to operate when either compressor started, which provided equal condensing facilities for each compressor. By maintaining a constant chilled water flow each compressor’s power consumption was compared under a constant evaporator load condition.

All chilled water pumps were set to manual 'ON' to provide constant flow through the test chiller.

Calibrated test gauges were used to measure and record the pressure drops across the chiller and pump. Each chiller and pump have butterfly valves which had been set at the original job start-up and the test chiller valves were taped and marked to insure no change in position during the test.

The chilled water supply and return thermometers were replaced with new thermometers selected to read the same at 45oF. A strip chan recorder was installed to read ambient air temperature entering the test chiller's condenser. All chillers were disconnected from the energy management system. The 120 ton Trane was set to control at 54oF return water temperature, and the Carrier was set for 48OF supply water. The 100 ton Trane test chiller was set to control at 44oF return water. These settings were designed to keep the test chiller 'ON', as it was expected that chilled water return would remain close to 52oF at all times because of the space requirements for 55oF supply air. A strip chan recorder was installed on the chilled water supply from the test chiller. The return water temperature was measured manually.

The following equipment ratings and definitions were used in evaluation of the test results:

Equipment Ratings:

1. The test chiller was a Trane CGAA-100-R, dual compressor, air cooled unit. At 55o CWR, 45o CWS, 225 gpm flow and 0.0005 fouling factors, is rated at:

115

Temp. (ent. Condenser)	75	80	85	90	95	105	108.8
KW	80.2	83.6	93.6	92.5	98.8	103.8	104
TONS	101	98	94.9	91.7	85.3	78.9	

These ratings are from Trane Engineering Bulletin EBCG-7.

Calculations:

2. TONNAGE = Delta T (oF) x Flow (gpm)

Definition:

3. The cooling degree days are defined as the 24 hour average temperature minus 65. For example, a day with a high temperature of 96oF, and a low temperature of 74oF, with an average temperature of 85oF, would be considered a 20o (85-65) degree cooling day. So would any other day with an average temperature of 85oF, outside temperatures within the 24 hour period do effect the total Kw consumption as the machine's Kw usage per ton varies from 1.37 Kw/ton @ 115oF to 0.77 Kw/ton @ 75oF. In a test of this duration, however the cooling degree day can be used to reflect trends and to compute power cost, with reasonable accuracy.

Preliminary Evaluation:

4. Two (2), 200 cooling degree days as reported by the National Weather Bureau were chosen to average the air temperature entering the condenser on an hourly basis. The average temperature was used to extrapolate a tonnage and Kw reading from the manufacturer's rating table. For every hourly temperature and Kw noted, it was assumed that the Kw stayed the same for the hours so that Kw became kwhr, which is the value used by the power company to arrive at billing cost dollars.

Test Procedures,

An Esterline Angus Power Surveyor was installed on one of the two, 50 ton compressors on the test chiller. This was identified as Compressor No. 1, and set to be the lead compressor. The accumulated Kw and kvar were recorded every 12 hours for 23 days beginning June 16 and ending June 29.

Frigi-Tech was installed in this compressor on June 29, by draining the appropriate amount of oil and replacing it with Frigi-Tech for a resultant mix ratio of 95 parts oil to 5 parts additive.

The machine was returned to normal operating conditions and the Esterline Angus recorded Compressor No. 1 for 18 days until July 8. The recorder was then removed and separate kilowatt,

counter type totalizers and run time, counter type meters were installed on both compressors in the chiller.

The chiller was left "on line" and no readings were recorded for a 20 day period from July 8 to July 27.

Beginning July 28, the 24 hour accumulated Kw were recorded each day for both Compressor No. 1 and No. 2. On August 8, Compressor No. 2 was treated with Frigi-Tech in the same quantity as Compressor No. 1.

Before removing the Esterline Angus Power Surveyor the meter was checked with a calibrated amp probe and stop watch. Its readings were accepted as accurate and reliable. The Intallimeter Kilowatt Registers were also checked and found to agree with the manually read data. The elapsed time meters have hourly readings recorded to the one tenth place. The recorders were checked and varied no more than 15 minutes in 24 hours.

The Intellimeters were not read everyday, however a combination of run time hours and Kw totals were used to convert all values to a day to day 24 hour basis, prior to September 1 - After that the totals were recorded daily at noon for each individual day.

The cooling degree days, daily high temperature and daily low temperature were obtained from the U.S. Weather Bureau in Alvin, Texas.

Test Results:

With the use of recorder pressure differential and the manufacturer's pump curve, it was established that the chilled water pump was providing a constant flow rate of 300 gpm. Using the gpm of flow multiplied by the recorder temperature differential across the chiller shows:

Tons (early test period) = 6.5 (F) x '300 gpm = 81.25 tons

24

Tons (last test period) = 7.5 (F) x 300 gpm - 93.75 tons

24

I.e. an increase in chiller capacity of 12.5 tons / day.

Comparison of the outside temperature reported by the weather bureau with the temperature recorded in the courtyard shows the condensing temperatures in the yard to be several degrees higher. This difference is attributed to recirculation of the condenser discharge air. The chiller's actual condensing temperature varies with wind direction, wind velocity, thermal updrafts, etc. In addition, the temperature varies across the face of the condenser from one end to the other. This is a complex measurement not within the capabilities of the test instrumentation. The decision to use degree day baselines was made with the assumption that @ variance in condenser ambient temperatures from outdoor temperature would remain relatively constant before and after application of Frigi-Tech would not, therefore, significantly alter the test results.

Conclusion:

The test chiller had an almost constant load on its evaporator throughout the test period. Therefore, the Kw usage varied only with the condensing temperature as measured by the outdoor air dry bulb temperature and as effected by the addition of Frigi-Tech to the compressors' oil sumps.

The test data was collected from noon June 16, 1989 until noon October 9, 1989. This is a total of 115 days which is a long enough period to obtain reliable data.

The average Kw consumption before *and after the addition of Frigi-Tech* were compared using the degree days. The Kw consumption was averaged for the degree days between 8 and 24. The Kw consumed per 24 hour period were calculated for 13 days prior and 32 after the treatment of both compressors with Frigi-Tech.

The average Kw consumed per 24 hour period decreased. After the addition of Frigi-Tech, from 2103.15 to 1806.20, or 296.95 Kw/24 hour period.

The number of cooling degree days with intensities of 8 to 24 for the twelve months, preceding the test start, totaled 270 days. It can be concluded that Frigi-Tech would have therefore resulted in a 12 month reduction in Kw consumed of:

270 days x 296.95 Kw/day - 80,176.50 Kw

This equates to a savings of:

80,176.50 Kw x $0.0725/Kw - $5,812.79 for the 270 day period.

It can be noted that the twelve month savings, following the application of Frigi-Tech, will actually be somewhat greater, due to the projected rate increases in the cost of power.

The daily power consumption reduction was 296.95/2103.15 x 100 - 14%.

The power used by the compressor is a direct measurement of work done by the compressor. Therefore, it is reasonable to expect the compressors, by doing 14% percent less work, will have a much longer service life.

In conclusion, the combined affect of electrical cost savings and increased compressor life due to the addition of Frigi-Tech, makes this a viable method to reduce both maintenance and operating costs.