

ENERGYMASTER® DESICCANT SYSTEM APPLICATION TO LIGHT COMMERCIAL BUILDINGS

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ABSTRACT

Desiccant cooling systems offer unique advantages over conventional equipment in certain applications. AskCorp's Energymaster unit has been applied in several commercial situations where these advantages are most significant.

The magnitude of operating cost savings and improved control is greatest in humid climates where both ambient enthalpy levels and space latent loads are highest.

TABLE 1

| City             | 2½% Design | Enthalpy | Tons Per<br>1000 CFM |
|------------------|------------|----------|----------------------|
|                  | Wet Bulb   |          |                      |
|                  | °F         | BTU/LB   |                      |
| Birmingham       | 77         | 40.7     | 3.34                 |
| Mobile           | 79         | 43.0     | 4.20                 |
| Phoenix          | 75         | 38.6     | 2.55                 |
| Little Rock      | 79         | 43.0     | 4.20                 |
| Los Angeles      | 70         | 34.2     | 0.90                 |
| San Diego        | 70         | 34.2     | 0.90                 |
| San Francisco    | 63         | 28.6     | -1.20                |
| Washington, D.C. | 77         | 40.7     | 3.34                 |
| Miami            | 79         | 43.0     | 4.20                 |
| Orlando          | 78         | 41.8     | 3.75                 |
| Atlanta          | 76         | 39.6     | 2.92                 |
| Chicago          | 75         | 38.6     | 2.55                 |
| New Orleans      | 80         | 44.0     | 4.57                 |
| Baltimore        | 77         | 40.7     | 3.34                 |
| Boston           | 74         | 37.0     | 1.95                 |
| Biloxi           | 81         | 45.0     | 4.95                 |
| St. Louis        | 77         | 40.7     | 3.34                 |
| Las Vegas        | 70         | 34.2     | 0.90                 |
| New York         | 75         | 38.6     | 2.55                 |
| Cleveland        | 74         | 37.0     | 1.95                 |
| Charleston       | 80         | 44.0     | 4.57                 |

sector, the dominant structure is the single story detached building. The environmental control system is generally made up of multiple rooftop, self-contained packaged units. These systems are operated in one of three configurations:

1. 100% recirculation.
2. Recirculation with makeup air.
3. 100% makeup air.

The Energymaster desiccant system offers unique advantages to each of these configurations in a humid climate providing both improved space control levels and significantly reduced operating costs.

HUMID CLIMATES

In humid climates two (2) factors are significantly different from the design parameters found in other areas: Very high ambient enthalpy levels and very low sensible to latent load ratios. Table 1 illustrates the design outside enthalpy values for various parts of the United States.

|             |    |      |      |
|-------------|----|------|------|
| Dallas      | 78 | 41.8 | 3.75 |
| Houston     | 79 | 43.0 | 4.20 |
| Midland     | 72 | 38.6 | 2.55 |
| San Antonio | 76 | 39.6 | 2.92 |
| Waco        | 78 | 41.8 | 3.75 |

It can be seen that, on an enthalpy basis, the load imposed by makeup air is much greater in the extreme humid zones of the United States. There are additional characteristics of the United States humid climate outside air patterns which are significantly different from both moderate and high temperature zones. The first is that the seasonal and diurnal wet bulb or enthalpy variations are small. For example, in July the usual wet bulb ranges in representative cities are:

|             |          |
|-------------|----------|
| New Orleans | 72 - 80F |
| Chicago     | 50 - 76F |
| Las Vegas   | 53 - 68F |

The fact that wet bulbs remain in a narrow band at high levels means the air conditioning loads are high and continuous over the cooling season.

In addition humid climates are characterized by reduced variations in dry bulb temperatures as evidenced by the following July ranges:

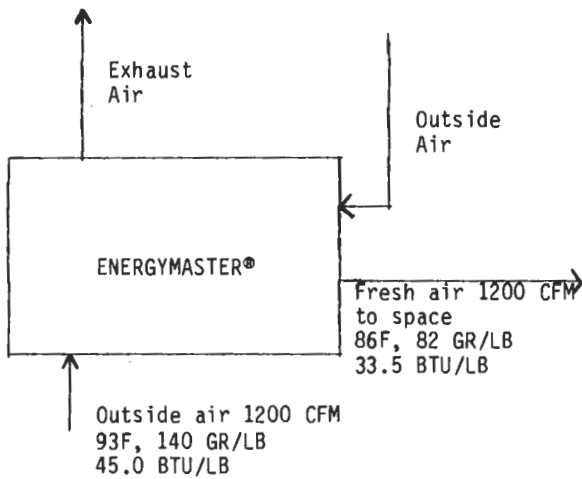
|             |           |
|-------------|-----------|
| New Orleans | 70 - 94F  |
| Chicago     | 50 - 94F  |
| Las Vegas   | 65 - 114F |

This means that not only are enthalpy load variations minimal, but humidity levels approach fixed high levels and latent transmission loads are nearly constant.

Sensible and latent loads are independent of one another. Unfortunately, in conventional air conditioning, latent cooling is dependent on sensible cooling; air is cooled to a temperature below its dewpoint condensing moisture on the cold surface. Latent cooling can be increased only by increasing sensible cooling rates. There are two (2) options available: reduce space dry-bulb set point to increase run time or over cool and reheat.

**MAKEUP AIR CONDITIONING**

The Energymaster Desiccant Cooling System provides alternatives to each of these situations. When used as a makeup air unit, its capacity is at a maximum and is far in excess of conventional units in terms of cooling per unit mass flow. Figure 1 illustrates a configuration for makeup air without benefit of exhaust.



|                   |             |
|-------------------|-------------|
| TOTAL COOLING:    | 62,100 BTUH |
| LATENT COOLING:   | 47,800 BTUH |
| SENSIBLE COOLING: | 14,300 BTUH |
| THERMAL COP:      | 1.0         |
| EER:              | 47.8        |

Fig. 1 Energymaster - Makeup Air Unit (No Return)

In a humid climate, 81°F WB, the 1200 CFM unit provides 5.2 tons of makeup air cooling or one (1) ton per 230 CFM. In a dry climate, 105°F DB, 70 WB the Energymaster's capacity would be somewhat lower, 3.7 tons.

In addition to its high capacity per unit mass of air treated it can offer significant operating savings. The basis for savings lies in the cost differential of natural gas and electricity. Figures 2 and 3 illustrate the range of savings as a function of the costs of gas and electricity.

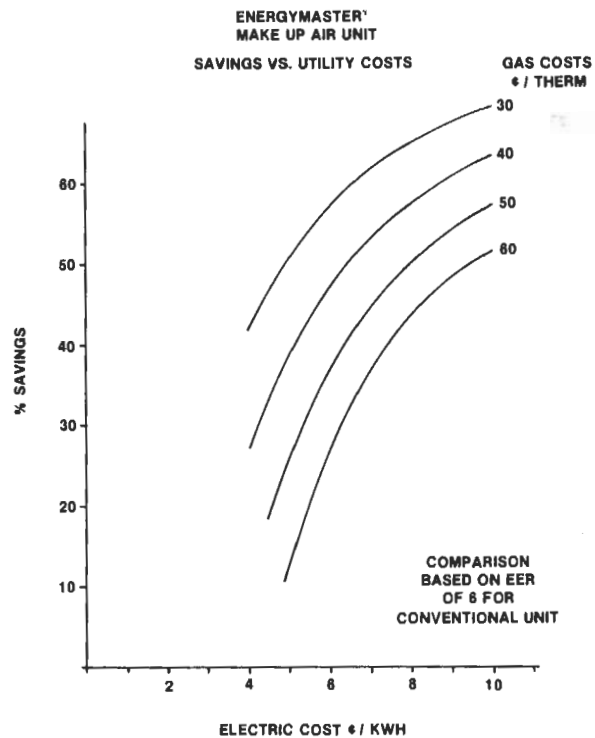


Fig. 2 Savings vs. Utility Costs

**HUMIDITY CONTROL**

Latent loads are analogous to sensible loads except that it is the difference in vapor pressure rather than temperature upon which external source loads depend. Figure 4 shows the moisture load on a typical 2,500 square foot convenience store as a function of indoor and outdoor humidity. The moisture removal rates for typical 2½, 5, and 7½ ton packaged airconditioners as well as an Energymaster unit are superimposed.

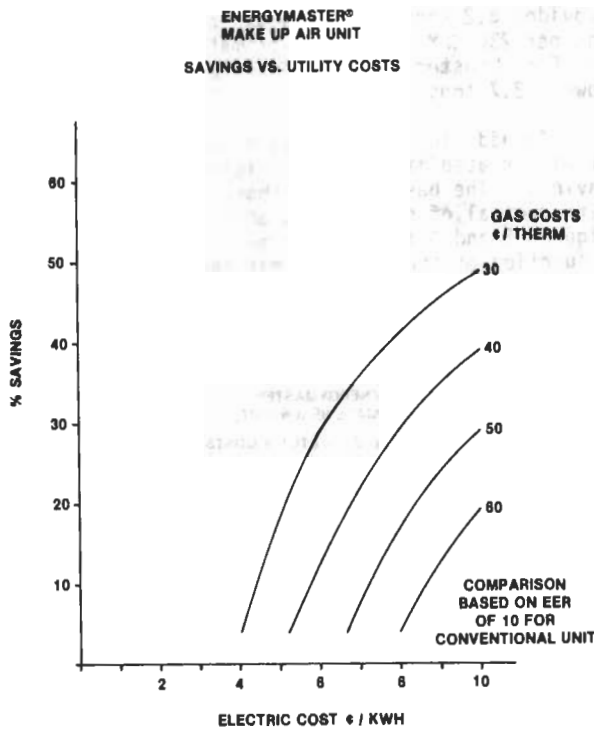


Fig. 3 Savings vs. Utility Costs

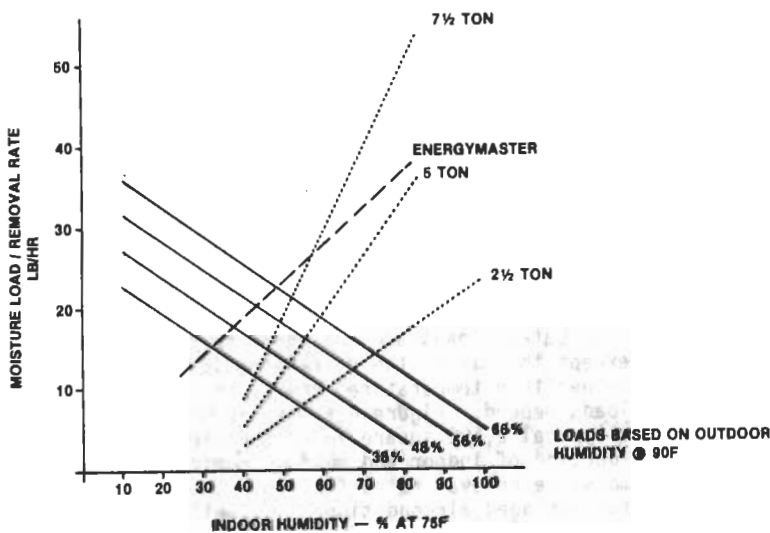


Fig. 4 Load Characteristics

The 5 ton and 2½ ton curves also approximate the 7½ ton unit running at 67% and 33% on-time. Reduced on-time is the typical condition encountered when sensible loads are reduced and simple thermostat control is employed. It is easy to see that under a high ambient humidity condition indoor humidity will vary from 52% to 73% depending upon sensible cooling requirements.

An Energymaster unit, however, can independently maintain humidity at any level above 48%. When an arrangement of an Energymaster unit controlling humidity and a conventional unit controlling temperature is employed not only is control maintained, but the sensible capacity of the conventional unit is increased significantly. At 73% R.H. a typical five (5) ton unit has a sensible capacity of 30,000 BTUH. At 50% R.H. it has a sensible capacity of 38,000 BTUH, an increase of 27%. At 38% sensible capacity increases to 49,000 BTUH.

CONCLUSIONS

In humid climates Energymaster has two (2) outstanding applications: treatment of makeup air and maintenance of indoor humidity levels. In 100% makeup situations it can replace units of up to six (6) tons. In combination recirculation/makeup air applications it can either unload a conventional unit or allow a conventional unit's full capacity to be utilized for space sensible cooling. As a humidity control device, it can maintain desired levels, increasing the capacity of conventional units for sensible cooling.

The Energymaster desiccant system has many applications, but in the two applications described, makeup air treatment and space humidity control, it has both capabilities and economies beyond those of conventional vapor compression units.