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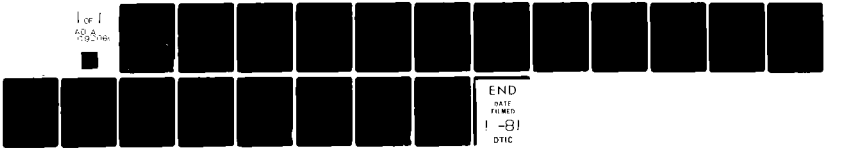

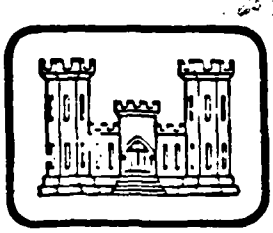

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FESA-TS-2087

# LAUNDRY HEAT RECOVERY, USMA, WEST POINT

Stephen L. Jones

September 1980



Final Report



Prepared for:

US ARMY FACILITIES ENGINEERING SUPPORT AGENCY
Technology Support Division
Fort Belvoir, VA 22060

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The purpose of this report is to determine the feasibility of retrofitting heat recovery devices to commercial size clothes dryers. Data used in the analysis was provided by the Energenics Corporation, Aurora, IL and the Energy Conservation Office, US Military Academy, West Point.

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## PREFACE

The purpose of this report is to determine the feasibility of retrofitting heat recovery devices to commercial size clothes dryers. Data used in the analysis was provided by the Energenics Corporation, Aurora, IL and the Energy Conservation Office, US Military Academy, West Point.

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## 1.1 DESCRIPTION

Conventional clothes dryers operate on a once-through airflow principle of 100% fresh air intake and exhaust discharged to atmosphere. Two methods to reduce the heat required to dry clothes are employed in equipment manufactured by the Energenics Corporation, which may be applicable to military laundry facilities. The first method uses a heat pipe type heat exchanger to preheat incoming air with energy recovered from the dryer exhaust. The second and newer method uses a microprocessor controlled recirculation technique to minimize the fresh air requirements. A third method is offered on new dryers from the original manufacturer which provides hot exhaust air to the burner in direct fired models to promote better combustion. This technique is not applicable to the steam heated types installed at West Point.

## 1.2 EQUIPMENT

A major requirement of any clothes dryer heat recovery system is high efficiency filtration of the exhaust air. Fouling of the heat exchanger or contamination of the load will occur unless virtually all lint is removed from the exhaust air steam. Both Energenics systems are equipped with two-stage exhaust filters to meet this rather stringent requirement.

The recirculation technique is advantageous in two respects; it eliminates the expensive heat exchanger and provides an "intelligent" microprocessor based controller. The "intelligent" controller should increase productivity and save energy by reducing cycle times. Exhaust is recirculated 100% at startup, rapidly bringing the dryer to operating temperature. The controller senses when a load is dry and terminates the cycle at that time. Varying load compositions and humidity conditions are automatically compensated for while minimizing energy consumption.

## 1.3 REQUIREMENTS

Installation of dryer heat recovery equipment requires a major alteration in ducting. After locating the filters and recirculation valve, ducting must be run to the filter from the dryer exhaust and to the dryer intake from the recirculation valve. If a dryer is steam heated and a cool-down cycle is desired, a solenoid operated steam valve is necessary. Duct insulation is required to minimize losses, particularly if the filter is located outdoors. A consideration in filter location is the requirement for emptying lint from the drop tube. It should be readily accessible to service personnel.

## 2.1 ENERGY RECOVERY

A water removal rate of .02088 pounds per minute per pound of dry air circulated is specified to be typical for satisfactory drying times.

Dryer exhaust conditions are about 210°F dry bulb and 120°F wet bulb, containing .058 lbs moisture/lb of dry air.

An exhaust and fresh air mixture must then have a moisture content not exceeding .058-.02088 = .0371 lb-$h_2$0/lb-dry air for a satisfactory removal rate.

By a comparison of humidity ratios, the amount of exhaust that can be recirculated is determined for various weather conditions.

Exhaust Airflow

6500 cfm @18.4 $ft^3$/lb = 353.26 lb/min

enthalphy = 116 Btu/lb

Cold Weather

30°F dry bulb, 50% relative humidity, .0017 lb-$h_2$0/lb-dry air

enthalpy = 9 Btu/lb

x = recirculated exhaust fraction

1-x = fresh air required

x (.058) + (1-x) (.0017) = .0371 lb-$h_2$0/lb-dry air

$$x = \frac{.0371 - .0017}{.058 - .0017}$$

x = .6288

62.9% recirculation x 353.26 lb/min
222.2 lb/min recirculated
x 107 Btu/lb Δ enthalphy

23,775 Btu/min saved

Moderate Weather

60°F dry bulb, 50% RH, .0066 lb-$h_2$0)/lb-dry air

enthalphy = 20.3 Btu/lb

$$x = \frac{.0371 - .0066}{.058 - .0066}$$

x = .5934

59.3% recirculation x 353.26 lb/min
209.5 lb/min recirculated
x 95.7 Btu/lb Δ enthalphy

20,047 Btu/min saved

Hot Weather

90°F dry bulb, 50% RH, .0152 lb-$h_2$0/lb-dry air

enthalpy = 38.6 Btu/lb

$$x = \frac{.0371 - .0152}{.058 - .0152}$$

$$x = .5117$$

51.2% recirculation x 353.26 lb/min
180.9 lb/min recirculated
x 77.4 Btu/lb Δ enthalpy

13,999 Btu/min saved

3.1 OPERATING ASSUMPTIONS

40 hours/week
drying 40 minutes/hour
recirculating 50% of drying time
weather conditions:
3 months - cold
6 months - moderate
3 months - hot

| Cold | Moderate | Hot |
|---|---|---|
| 9,600 minutes | 19,200 minutes | 9,600 minutes |
| 23,775 Btu/min | 20,047 Btu/min | 13,999 Btu/min |
| 228.24 MMBtu | 384.90 MMBtu | 134.39 MMBtu |

Total 747.48 MMBtu/yr

Heat content #6 fuel oil - 149,690 Btu/gal
x boiler efficiency .80

Available heat/gal 119,752 Btu/gal

Fuel Oil Savings $\frac{747,480,000 \text{ Btu/yr}}{119,752 \text{ Btu/gal}}$ = 6,242 gal/yr

## 4.1 ECONOMIC ANALYSIS*

| Year | Fuel Saved | Fuel Cost/Gal | Cost Savings | Discount Factor | Discounted Savings | Net Present Worth |
|---|---|---|---|---|---|---|
| '81 | " | $ .71 | $ 4,432 | .991 | $ 4,392 | $ 4,392 |
| '82 | " | $ .81 | $ 5,056 | .973 | $ 4,919 | $ 9,312 |
| '83 | " | $ .92 | $ 5,743 | .955 | $ 5,485 | $ 14,796 |
| '84 | " | $ 1.05 | $ 6,554 | .938 | $ 6,148 | $ 20,944 |
| '85 | " | $ 1.19 | $ 7,427 | .921 | $ 6,840 | $ 27,784 |
| '86 | " | $ 1.36 | $ 8,489 | .904 | $ 7,674 | $ 35,458 |
| '87 | " | $ 1.54 | $ 9,613 | .888 | $ 8,536 | $ 43,994 |
| '88 | " | $ 1.54 | $ 9,613 | .871 | $ 8,373 | $ 52,367 |
| '89 | " | $ 1.54 | $ 9,613 | .856 | $ 8,229 | $ 60,596 |
| '90 | " | $ 1.54 | $ 9,613 | .840 | $ 8,075 | $ 68,671 |

Assuming a $14,000 purchase price and $6,000 installation cost, a reclamation system will pay off in slightly less than 4 years. The cost/benefit ratio is 3.43 assuming a 10-year life. If a new filtration system is required for OSHA lint compliance, the extra cost of the recovery device will be amortized in about half the time as the complete system.

## 5.1 CONCLUSIONS

Based on the economic analysis and the Army goal to reduce energy consumption, the laundry heat recovery devices appear to be worthwhile investments.

Since most laundry dryers require considerable retrofit to comply with OSHA lint emission requirements in any case, the heat recovery option appears to be an especially attractive investment.

*Discount factors from '78 AFEP, 10% discount, 8% differential inflation rate.

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