CertainTeed	Date	To	Location and mail code
	June 1, 1979	D. Wigfield	2126
Subject: CROSS BLOWING OF STEAM BETWEEN AUTOCLAVES AT THE A/C PLANTS		From: F. Niedergang	Location and mail code: 2126

PLAINTIFF'S EXHIBIT

CT-1472

Reference: G. Stelian -- D. Wigfield 3-6-79
D. Wigfield -- G. Stelian 3-16-79
F. Niedergang -- F. Hawkins 5-21-79

Please find enclosed a report from Fred Hawkins dated May 30, 1979 concerning this subject. Given the continued increase in energy costs for the last few months, it is necessary that you have an evaluation done of the cost of the modifications to be made to the autoclaves in each plant. You can contact Fred Hawkins directly, for the definition of the necessary equipment. You can split up your price studies, beginning with the Ambler plant and the Hillsboro plant.

cc: T. Dougherty
L. Ambler
J. McGillicuddy
G. Stelian

FN/pha

RECEIVED JUN 1979

01-25-0005

CTD001291

CertainTeed	Date	To	Location and mail code
	May 30, 1979	Mr. F. Niedergang	#2126
Subject: CROSS-BLOWING OF STEAM BETWEEN AUTOCLAVES AT THE A/C PLANTS		From: Mr. F. E. Hawkins	Location and mail code: #2126

In answer to your request of May 21st, I have reviewed cross-blowing and evaluated it against present fuel costs. Company-wide $45,600 in fuel could be saved yearly at current fuel costs. The cost would be some reduction in autoclave capacity and the cross-blowing connections.

I have gone on past this to calculating the savings if we went all-out to save the heat in the condensate, and recover some of the heat in the pipe and autoclave as well as the heat in the steam. Savings yearly would be $239,000 with the same expenses as above plus additional expense for pumps, sprays, and some autoclave modifications.

Attachment

STEAM SAVINGS BY CROSS-BLOWING AUTOCLAVES

Summary

Cross-Blowing Autoclaves is usually considered to be the discharge of the steam in an autoclave at the end of the cycle into an autoclave just starting up. This report gives the savings in fuel costs which can be made by doing this and then goes further to describe how even greater savings may be made.

The savings can be summarized as follows based on 100 foot long autoclaves:

	Savings Per Year	
	Conventional Cross-Blowing	Improved Cross-Blowing
Ambler	$14,700	$77,000
Riverside	8,200	43,000
Santa Clara	6,100	32,000
Hillsboro	16,600	87,000
	$45,600	$239,000

No amortization of cost of autoclave modifications.

Background Information

Cross-blowing of autoclaves has been investigated in the past and with low cost fuel it did not seem worth the scheduling problems and the loss of autoclaving time resulting from extending the heat-up and pressure release phase of autoclaving. Now that fuel prices have increased, it is time to look at cross-blowing again and the ways to make cross-blowing more efficient.

Conventional Cross-Blowing

An autoclave contains hot pipe, a hot autoclave shell, hot autoclave cars and trays, steam under 150 lbs/sq.in. pressure, and a small amount of hot condensate. The only heat that is saved by cross-blowing is the heat in the compressed steam. In an autoclave 100 feet long this amounts to 981 lbs. of steam per autoclave cycle (Calculations page 6).

Plant	Savings $/Autoclave Cycle	Savings Per Year
Ambler	$5.99	$14,700
Riverside	3.33	8,200
Santa Clara	3.33 Est.	6,100
Hillsboro	3.38	16,600
		$45,600

In Ambler and Hillsboro this is getting to be worth the trouble but hardly worth it in the other plants.

Improved Cross-Blowing

To make cross-blowing worth the trouble, the savings should be increased and I propose doing this by utilizing some of the heat in the pipe, trays and autoclave shell and the heat in the condensate. This would be done by the following means:

1. Raise the condensate outlets so all of the condensate is retained in the autoclave.

2. Install a pump and sprays so that the condensate can be sprayed over the pipe and on the autoclave walls.

3. Interconnect the autoclaves so the steam from the autoclave finishing its cycle will go to an autoclave just starting up.

The results would be as follows - when the autoclaves are cross-connected the pump is turned on. Spraying the walls of the autoclave, the pipe, and the trays extracting heat as steam. It is assumed that the temperature can be reduced 100°F by spraying. Reducing the pressure turns more of the condensate to steam and the steam under pressure in the autoclave goes to the fresh autoclave. Calculations are given on page 7 and can be summarized that in one autoclaving 5,141 pounds of steam can be saved.

On a yearly basis savings would be:

Ambler	$77,000
Riverside	43,000
Santa Clara	32,000
Hillsboro	87,000
	$239,000

Discussion

The savings are based on cooling the autoclave and contents 100°F, reducing the condensate temperature from 366°F to 220°F, and reducing steam pressure to 10 psi by cross-blowing. For cooling the autoclave and contents a 75% efficiency is used to correct for possible poor spray coverage.

The modifications necessary for the autoclaves are not extensive. The condensate drains should be raised so that 203 cubic feet of condensate can be retained in the autoclave. This raises the water level to a depth of 10 inches (Calculation page 9). This may require some changes in autoclave car wheel bearings.

The condensate spray system should have well insulated lines and should spray the pipe and the autoclave walls. A 100 gpm pump on each autoclave should be adequate. This would spray 800 lbs. per minute and since cool down will take 30 to 60 minutes this rate of flow should be adequate. The pump can also be used to clear the condensate from the autoclave.

The pumping system gives an opportunity to spray the pipe during autoclaving which should yield better and more uniform pipe strength.

Recommedations

This idea should be verified in the Ambler plant and put into use if it proves warranted.

F. E. Hawkins

F. E. Hawkins
May 30, 1979

Autoclave Energy Calculations

150 psig steam pressure

A. Btu to heat autoclaves, trays and cars.

Weight of autoclave and cars	115,000 lbs.
Specific heat Btu/°F Δ T lb.	.1
Δ T	306°
Btu/autoclave charge	3,500,000
Pounds of Steam - at 860 Btu/lb.	4,070 lbs.

B. Btu to heat pipe and sand

Weight of pipe and sand	48,900 lbs.
Specific heat assume 15% moisture	.32
Δ T	306°
Btu/autoclave charge	4,800,000
Pounds of Steam - at 860 Btu/lb.	5,580 lbs.

C Heat loss to atmosphere

Square feet of surface	2,277
Conductivity	.175
Hours at Temperature	10
Δ T	306°
Btu/autoclave charge	1,200,000
Pounds of Steam - at 860 Btu/lb.	1,490 lb.s

D. Total Condensate 11,140 lbs.

Heat available in cooling from 366°F to 220°F	146 Btu/lb.
Total heat available as steam	1,600,000 Btu
Volume of Condensate at 366°F (.01819 cu.ft./lb.)	203 cu.ft.

E. Steam in Autoclave Improved Cross-Blowing

Volume of Steam Cu.Ft. 3174-203	2,971 cu.ft.
Cubic ft. per lb. steam at 150°F	2.8
Pounds of Steam	1,100 lbs.
Cubic feet per lb. of steam at 10 psi	163
Pounds of steam at 10 psi	182
Pounds of steam recoverable	918 lbs.

F. Steam in Autoclave Regular Cross-Blowing

	Volume of Steam	3,174 cu.ft.
	Cubic ft. per lb. steam 150 psi	2.7
	Pounds of steam 150 psi	1,176 lbs.
	Cubic ft. per lb. steam 10 psi	16.3
	Pounds of steam at 10 psi	195
	Pounds of steam recoverable	981

Cost of Fuel per 1,000 lbs. Steam

Assume boilers are 75% efficient in making steam at 150 psi

1,000 lb. steam absorbs 1,168 Btu from fuel

1,000 lb. steam at 75% boiler efficiency requires 1,557 Btu in Fuel

Gallons of #6 oil/1,000 lb. steam

1,557,000 ÷ 145,360 = 10.7 gal oil/1,000 lb. steam

Oil cost/1,000 lbs. steam

10.7 x $.56/gal. = $5.99

Assuming the same efficiency for the boilers in the other plants:

Riverside

(1,557,000 ÷ 10,400,000) Btu/10^3 cu.ft. x $2.223 = $3.33/1,000 lbs.

Hillsboro

1,557,000 ÷ 10,040,000 x $2.253 = $3.37/1,000 lbs.

Santa Clara est. $3.33/1,000 lbs.

Savings by Regular Cross-Blowing

$\frac{981}{1000}$ lb. of steam x $/1,000 lb. =

	Per Cycle
Ambler	$5.88
Riverside	3.27
Hillsboro	3.31
Santa Clara	3.27

Savings possible per year 2,500 autoclavings Ambler and Riverside, 1,875 at Santa Clara, 5,000 at Hillsboro.

Per year at	X cycles/day 250 days/year		
Ambler	10 x 250 x $5.88	=	$14,700
Riverside	10 x 250 x 3.27	=	8,200
Hillsboro	20 x 250 x 3.31	=	16,400
Santa Clara	7.5 x 250 x 3.27	=	6,100
			$45,400

Savings by Improved Cross-Blowing

Assume spraying water in autoclave cools pipe, trays and autoclave shell to 266°F for a Δ T of 100°F. Heat is recovered as steam.

A. Heat from shell and steel

115,000 lb. x 100 Δ T x .1 sp.ht. = 1,150,000 Btu

B. Heat from pipe

48,100 x 100 x .32 = 1,560,000 Btu

C. Heat Saved by Condensate Spray A&B Max. 2,710,000 Btu

Assume 75% Efficiency 2,032,500

Pounds of Steam at 860 Btu/lb. 2,363 lbs.

D. Heat from Cooling Condensate to 220°F

11,140 lb. x 146 Δ T x 1 SpHt = 1,600,000 Btu

Pounds of Steam at 860 Btu/lb. 1,860 lbs.

E. Steam saved from steam in autoclave 918 lbs.

TOTAL STEAM SAVED C & D & E 5,141 lbs.

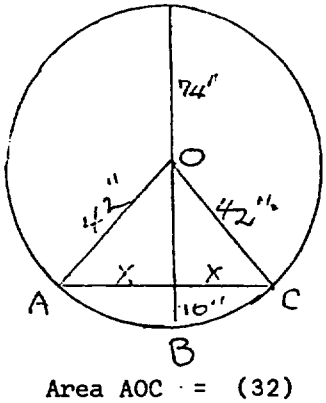
Savings possible per year 2,500 autoclavings Ambler and Riverside, 1,875 at Santa Clara, 5,000 at Hillsboro.

Ambler	$5.99 x 5.141 x 2500	=	$77,000	/year
Riverside	3.33 x 5.141 x 2500	=	43,000	
Santa Clara	3.33 x 5.141 x 1875	=	32,000	
Hillsboro	3.37 x 5.141 x 5000	=	87,000	
	POSSIBLE SAVINGS		$239,000	

Calculations of Depth of Condensate in the Autoclave

Autoclave Diameter	7	feet
Autoclave length	100	feet
Volume of Condensate	203	cu.ft.

Assume depth of 10", how many cubic feet of condensate:



$X^2 = 10 \times 74$

$X = 27.2$ inches

$$\text{Area ABCO} = 2\left(\sin^{-1}\frac{27.2}{42}\right) \times \frac{1}{360} \times \frac{84^2}{4} 1T$$

$= 1243$ sq.in.

$$\text{Area AOC} = (32)(27.2) = \frac{870}{373} \text{ sq.in}$$

Area ACB

$$\frac{373}{144} = 2.59 \text{ sq. ft.}$$

Cubic Feet (2.59) (100) = 259 cu.ft.

Needed 203 cu.ft.

Therefore, providing for a 10 inch depth of condensate in the autoclave should be sufficient.