PUBLISHED · CAIN INDUSTRIES · RE-MODELLED

VX-SHR — sensible heat recovery

University Campus, United States: three EM-28 units on 4.64 t/h steam boilers

A published installation by Cain Industries — duty, temperatures and flows are theirs. We re-ran the published inputs through the PULSE method to get the number a case study usually leaves out: how much of the fuel bill it actually is, in US, Vietnamese and metric units.

01 · PLANT PROFILE

Plant profile

CUSTOMER

University Campus · California, United States

APPLICATION

University central plant · steam boilers · retrofit of an existing installation

BOILERS

3 × EM-28 · 4,021 HP (3,000 kW) each · 4.64 t/h each · 9,000 kW installed

STEAM CONDITION

7 bar(g) · 101.5 psig · saturated steam 170.4 °C / 338.7 °F · 4.64 t/h

RECOVERY EQUIPMENT

EM-28 × 3 — VX-SHR, sensible heat recovery only, no condensing stage

FLUE GAS

490 → 300 °F at 1,750 SCFM

HEAT SINK

30 GPM, +26 °F rise — boiler feedwater

RECOVERED DUTY (PUBLISHED)

400,000 BTU/h

SOURCE

Cain Industries — published case study

02 · BASELINE — BEFORE RECOVERY

Baseline — before recovery

The campus central plant ran its boilers with no heat recovery on the flue: gas left at 490 °F and went to the stack. Every hour of operation spent fuel to make steam, and part of that fuel went out of the chimney as sensible heat.

The baseline is the published design point — flue gas at 490 °F, 1,750 SCFM, feedwater entering the recovery unit at 30 GPM and leaving 26 °F warmer. Those figures are Cain's for this installation and we have not altered them.

What the boundary contains

One central plant: three steam boilers and their common flue path, plus the feedwater loop the recovery unit heats. Fuel in, steam out, flue temperatures in and out of the unit, water in and out.

03 · SOLUTION — WHAT WAS INSTALLED

Solution — what was installed

Three **EM-28** heat-recovery units were installed, one per boiler, each taking sensible heat out of the flue gas and putting it into boiler feedwater. Flue gas leaves the boiler at 490 °F and leaves the recovery unit at 300 °F at 1,750 SCFM; the water side runs 30 GPM with a 26 °F rise.

As with the hospital case, this is sensible-only. The existing sink runs at 160 °F, far above the 131 °F dew point of the flue gas, so a condensing stage on that sink would recover nothing and no condensate or water saving is claimed.

Equipment

EM-28, three units, one per 4,021 HP boiler. Sensible heat recovery from the flue gas into feedwater.

Why not condensing

The sink at 160 °F cannot take the flue below its dew point. On a new build the second stage would need a cold sink — make-up water at about 80 °F — and that is a water-side decision, not an economizer decision.

04 · MEASURED RESULTS

Measured results

The duty and temperatures below are Cain Industries' published design data for their own installation. We have not re-measured them; what we changed is the arithmetic, expressed here in three unit systems so the same plant cannot be quoted two different ways.

3.13 %
of the fuel bill saved — dry stage only

0.40 MMBtu/h
recovered duty, published (400,000 BTU/h)

$21,000
fuel saving per year, modelled

5.7 months
payback, on a $9,962 installed cost

PUBLISHED DUTY, RE-EXPRESSED IN THREE UNIT SYSTEMS · ONE SET OF READINGS, NO CONVERSION MISTAKES

QUANTITY	Recovered duty
UNITED STATES	400,000 BTU/h · 0.40 MMBtu/h
VIETNAM	117 kW · 703 MWh/yr
OTHER (METRIC)	117 kW · 703 MWh/yr

QUANTITY	Flue gas temperature
UNITED STATES	490 → 300 °F
VIETNAM	254.4 → 148.9 °C
OTHER (METRIC)	254.4 → 148.9 °C

QUANTITY	Annual fuel (as saved)
UNITED STATES	30,000 therm
VIETNAM	3,165 GJ · 703 MWh
OTHER (METRIC)	2,532 GJ

QUANTITY	Annual saving
UNITED STATES	$21,000
VIETNAM	552,300,000 VND
OTHER (METRIC)	€19,320 · £16,590

QUANTITY	CO_2 avoided
UNITED STATES	175.3 short tons
VIETNAM	159.0 tonnes
OTHER (METRIC)	159.0 t

QUANTITY	Recovered duty
UNITED STATES	**400,000 BTU/h**
VIETNAM	**117 kW**
OTHER (METRIC)	**117 kW**

05 · SAVINGS AND PAYBACK

Savings and payback

A boiler putting out 10,236 MBH at 80 % efficiency burns 12,795,525 BTU/h of fuel. The recovery unit takes 400,000 BTU/h back out of the flue, so the saving is 400,000 / 12,795,525 = **3.13 %** of the fuel bill.

At 6,000 running hours a year that is 30,000 therm, and at $0.70/therm it is **$21,000 a year**. Cain publish a saving of $13,924/yr for the same installation, which implies about 3,978 running hours a year at that gas price; again the difference is run-hours, not efficiency. On an installed cost of $9,962 the modelled payback is **5.7 months**.

What the condensing case would add, and why it is not claimed here

Adding a cold sink (make-up water at about 80 °F) would let the flue be taken below its 131 °F dew point. The flue holds 1,596,382 BTU/h (12.48 % of fuel) below that point, the sink could absorb 600,000 BTU/h (4.69 % of fuel) at 30 GPM with a 40 °F rise, and taking it all would need 80 GPM. Combined, the two-stage logic would reach 3.13 % + 4.69 % = **7.82 %** of fuel — the same pattern our own demo plant reports as 3.98 % + 4.49 %. Those numbers are modelled from published design data, not metered.

06 · VERIFICATION METHOD

Verification method

This is a manufacturer-published installation, not a site we instrumented. Duty, temperatures, flows and the published payback are Cain Industries' figures for their own customer; we re-ran the inputs through the PULSE model and state every assumption so the arithmetic can be checked.

The same inputs are seeded as a modelled site in PULSE (`p_cain_csulb`), where the application's own efficiency calculation returns 5.32 % on the first boiler — the number on this page is reproducible in the product, not just in a spreadsheet.

On a real project the design duty is replaced by meters: fuel, gas temperature before and after the unit, water in and out, and condensate mass flow where a condensing stage exists. That is what turns a design figure into a re-derivable saving under the M&V protocol.

07 · BEFORE AND AFTER

Before and after

BEFORE

490 °F

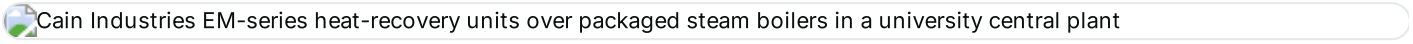
flue gas straight to the stack
fuel bill 100 %

→

AFTER

300 °F

3.13 % less fuel
$21,000 a year


Cain Industries EM-series heat-recovery units over packaged steam boilers in a university central plant

Cain heat-recovery units on the boiler flue — the installation this page re-models, as published by the manufacturer.

Photo: Cain Industries

08 · DOWNLOAD, SOURCES AND WHAT THIS DOCUMENT IS

Download, sources and what this document is

Download case study (PDF)

All case studies

What this document is. A published installation by Cain Industries, re-modelled by Vegax Energy. The customer is Cain's customer, not ours, and the plant is not instrumented by us. Design data is theirs; the percentages, the money and the condensing case are our model, stated with their assumptions so anyone can redo the arithmetic.

- Cain Industries — exhaust heat recovery case studies — customer, model, temperatures, flows, unit cost and published payback.
- Cain Industries — CXL single-stage and DXL two-stage condensing series, used for the condensing comparison.

The 55 °C line: flue-gas dew point

M&V protocol

All case studies