TWO STAGE ECONOMIZER PRODUCT GUIDE

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OVERVIEW

Cleaver-Brooks, the innovator in packaged boiler designs, introduces the C2X line of condensing economizers with the unique ability to maintain peak efficiency while firing different fuels and while liquid flow rates through the system vary from 0-100%. These SYSTEMS are unmatched in the industry and can deliver up to 95% fuel to steam efficiency.

The lower section of the economizer recovers energy by preheating the boiler feed water. The upper section preheats virtually any cool liquid stream (makeup water, wash water, hot water preheating, etc.) and the control system maximizes condensing when firing natural gas, then automatically switches to a near condensing mode when firing #2 oil (if applicable).

FEATURES AND BENEFITS

Reduces Fuel Use and Cost:

- Recovers heat from flue gases that would otherwise be wasted.
- Heat is used to raise boiler feedwater temperature prior to entering the boiler.
- Typical payback is less than one year

Load Changes:

- Rapid changes in load demands can be met faster due to higher feedwater temperature.

Emissions:

- Reduced fuel-firing rates for any given steam output means reduced NOx emissions.
- Reduce your fuel cost by up to 15% over a conventional steam boiler
- Reduce Greenhouse gas emissions by up to 15%

ASME Construction:

- Ensures high quality design and manufacturing standards.
- Provides safety and reliability.

High Efficiency Heat Exchanger:

- Provides uniform fin-to-tube contact for maximum heat transfer.
- Fin tubing offers up to 12 times the heat exchange surface of bare tubing of the same diameter.

Self-Draining Design:

- Suitable for outdoor installation.

Low Pressure Drop:

- Provides low gas side pressure drops.
- Permits use of smaller forced draft fans.
- Permits use of existing fans in almost all installations.

Gas Tight Combustion Stack:

- Stainless Steel casing.
- Compact dimensions provide for easy installation

Condensing Economizer Control Options

- Hawk ICS Advanced
  - 10" color HMI
- CEC200
  - 5.7" color HMI
  - 8 DI, 4 AI, 6 RO
- CEC100
  - 2" LCD
  - 8 DI, 4 AI, 6 RO

Application

1st Stage

- Preheat Boiler Feedwater
  - Running Feedwater directly through the economizer (direct feedwater heating) – continuous run pump and modulating feedwater control is required.
- On/Off Feedwater Control
  - Convert to modulating control OR
  - Supply Circulating Pump and Tank System must be proposed
    - Circulating pump and tank systems are only available up to 150 lb boiler design pressure.
      - Storage Tank Selection
        - Based on MBH of Economizer Recovery
  - General rule of thumb is to pick 20-30 GPM for the circulating pump flowrate.
  - Minimum water flow rate through the economizer should be the maximum evaporation rate of the boiler.
  - Add liquid temperature control assembly
    - ByPass Damper Open reduces the heat recovery by up to 50%
    - May need additional means of removing the excess heat within the system.

- Make-Up Water / Process Water Heating
  - Must have Minimum of 50% makeup to ensure a sufficient heat sink
  - Even with this guideline, flow may still be interrupted, which can cause steaming in the economizer.
    - Add a tank and pump upstream of the feedwater tank.
    - Then flow is not interrupted.
  - Recommend SS Headers (All SS Liquid Side)
    - Untreated Condensate – Carbonic Acid
    - MU Water – O_2 Corrosion
  - If water is less than 150°F, may recommend a C1X – Single Stage Condensing Economizer
- Hot Water Return
  - Supply Circulating Pump to draw water from, and return it to, the system hot water return.
  - Use approximately 2-3 gpm per economizer tube as the minimum water flow rate.
  - Note:
    - Saturated Steam Temp versus Feedwater Temperature
      - High Fire use lowest flow possible to keep a Temperature difference of 15 or 20°F below the sat. temp of the boiler
  - Supply Temperature + Boiler Delta T (LPS/HW) = Flue Gas Temp

2nd Stage

- Any Cool Liquid Stream (50 - 120 F)
  - Make-Up Water
    - Utilize the valve package and controls to feed water through the second stage and into the DA
  - Process Water
    - Circulating pump or storage tank may be needed.
    - Have to ensure continuous flow through the second stage when the boiler is in operation
  - Wash Water
    - Circulating pump or storage tank may be needed.
    - Have to ensure continuous flow through the second stage when the boiler is in operation
  - Hot Water Preheating
    - Supply Circulating Pump to draw water from, and return it to, the system hot water return.
    - Use approximately 2-3 gpm per economizer tube as the minimum water flow rate.

GUIDE

Tab 1: Application Data

Number of Boilers fed by DA

- The number of boilers selected determines the options for controls
- 1 Boiler is selected an existing Hawk, new Hawk, or CEC controller can be utilized
- Greater than 1 boiler requires a separate CEC-20x controller to monitor the economizer

Boiler Model Selection

- Select the correct Cleaver Brooks boiler model.
- For non Cleaver Brooks models select "Other"

Fuel Series

- Natural Gas Only:
  - Condense Temperature ~140°F
- Natural Gas and/or #2 Oil:
  - Natural Gas Condense Temp ~140°F
  - #2 oil Condense Temperature: ~180°F
    - Note: Economizer CANNOT be using the Condensing Mode when firing #2 Oil

Flue Gas Temperatures

- Predicted Values are Calculated
- Can override the Defaulted Value

Feedwater Temperature

- Minimum Temperature: 200°F
- Maximum Temperature: 230°F

2nd Stage Inlet Water Type

- Options
  - Make Up, Percentage
  - Process, gpm

2nd Stage Inlet Water

- Make Up, Percentage
  - Minimum: 50
  - Maximum: 200
- Process, gpm
  - Minimum: 50% of Feedwater Flow Rate (gpm)
  - Maximum: 200% of Feedwater Flow Rate (gpm)

2nd Stage Inlet Water Temperature

- Minimum: 50°F
- Maximum: 110°F

Exhaust Flow Direction

- Options:
  - Vertical
  - Horizontal
- Default: Vertical

Tab 2: Economizer Selection

Boiler Data Display

- Display field in the upper left corner
- Shows the Boiler Information formed from Tab 1 Selections

Model Selection

- C2X Economizer model is selected based on Horsepower
  - 100-2200 HP high pressure
- C2X Features
  - All upper coil components are 316 stainless steel
  - All gas side surfaces are 316 stainless steel to eliminate corrosion
  - Tube core assemblies are individually removable and made from 316 stainless steel tube with Aluminum fins (Al-Fuse)
  - Tube to header connections are externally located compression fitting, no welding is required for tube replacements
  - 316 stainless steel exhaust gas bypass, interior shell, condensate drain, and transition connections
  - 2" of factory insulation, inlet/outlet gaskets, ASME relief valves, and drain are included
  - Hinged, full face access door for inspecting
  - ASME Stamp-SEC.VIII:DIV.I(“UM”)
  - Removable tubes with unions and Swagelok fittings
  - Tube replacement without welding or cutting
  - Hinged access door
  - UM stamp standard
  - Removable panels allow for complete cleaning
  - Built-stainless steel condensate pan and drain
  - Built in by-pass damper
    - Allow manual stack temperature control and heat adjustment
  - Standard design pressure of 300 psig – higher pressures are also available
  - 12 gauge 316 stainless steel exterior

- Internal bypass for W.C. back pressure control
- The upper coil, lower coil, modulating valves, control system and other system components are sized as a system to deliver the maximum possible cost savings.

Boiler HP	Economizer Model	Length (in.)	Width (in.)	Height (in.)	Liquid Conn.	Surface Area (ft^2)	Dry Wt. (lbs.)	Wet Wt. (lbs.)
100	C2X-K3466AL	52	43	43.92	2"	635	1105	1166
125	C2X-K36a6AL	52	43	59	2"	1079	1545	1647
150	C2X-K37C6AL	52	43	67.6	2"	1335	1805	1931
200	C2X-K3Ac6AL	52	43	76.3	2"	1590	2045	2195
300	C2X-M38B6AL	70	58	65.5	2"	1907	2401	2575
400	C2X-M3Ac6AL	70	58	76.3	2"	2383	2861	3078
500	C2X-R3Ac6AL	80	66	76.3	2.5"	2780	3255	3501
600	C2X-R3BE6AL	80	66	87	2.5"	3337	3785	4080
700	C2X-S3BE6AL	88	73	87	2.5"	3813	3995	4336
800	C2X-S3Cf6AL	88	73	97.8	2.5"	4450	4601	4998
900	C2X-T3Df6AL	98	82	102.14	2.5"	5291	5455	5952
1000	C2X-T3DH6AL	98	82	108.6	2.5"	5720	5865	6402
1100	C2X-T3Ei6AL	98	82	119.4	2.5"	6435	6555	7159
1200	C2X-U3DH6AL	106	90	108.6	2.5"	6355	6415	6999
1300	C2X-U3EI6AL	106	90	119.4	2.5"	7150	7175	7831
1400	C2X-U3FK6AL	106	90	130.17	2.5"	7945	7935	8664
1500	C2X-U3Gl6AL	106	90	141	2.5"	8740	8695	9534
1800	C2X-U3HN6AL	106	90	151.7	2.5"	9535	9455	10370
2200	C2X-U3JQ6AL	106	90	173.3	2.5"	11123	10975	12041

Economizer Model Displays

- Displays all of the information once an Economizer model is selected
  - Economizer Weights and Dimensions
  - Natural Gas Estimated Performance

Tab 3: Economizer Options

Relief Valves

- Recommend
  - (1) 1st Stage
    - ¾" NPT ASME Relief Valve: 300psig
      - Default: 150 Desig Pressure
    - ¾" NPT ASME Relief Valve: 400psig
      - Default: 200ST, 250ST
  - (1) 2nd Stage
    - ¾" NPT ASME Relief Valve: 300psig
      - Default

Economizer Design Pressure

- If ¾" NPT ASME Relief Valve: 300psig Selected
  - 1st Stage: 300psig / 2nd Stage: 300psig
- If ¾" NPT ASME Relief Valve: 400psig Selected
  - 1st Stage: 400psig / 2nd Stage: 300psig

Boiler Vent Mating Flanges and Gaskets

- C2X Models Option

Flange Size (CB Mating Flange)	Mating Flange Gasket
12" I.D.	12" I.D.
16" I.D.	16" I.D.
18" I.D.	18" I.D.
20" I.D.	20" I.D.
24" I.D.	24" I.D.
32" I.D.	32" I.D.
36" I.D.	36" I.D.
42" I.D.	42" I.D.

Modulating MakeUp Valve

- Modulating Make-Up ByPass, 1/2" NPT, N.C. Valve
- Recommended in Make-Up Flow applications
  - Valve diverts Make-Up Water into the second stage to help prevent steaming
- Not Required for Process Flow Applications

3-Way Condensate ByPass Valve V3 (Three Way Diverting Valve)

- Recommended in Make-Up Flow Applications
- Diverts Condensate to the Second Stage when Steaming is sensed
- Size Based on Specified Pressure Drop and Boiler Flow Rate
  - Pressure Drop
    - Minimum: 5psi
    - Maximum: 20psi
  - Optional Sizes
    - 1" NPT (Cv = 10)
    - 1-1/4" NPT (Cv = 16)
    - 1-1/2" NPT (Cv = 25)
    - 2" NPT (Cv = 40)
    - 2-1/2" NPT (Cv = 63)

Flow Balancing Valves

- Recommended in Make-Up Flow and Multiple Boiler/Economizer Applications
- Require (1) Valve per Economizer
- Ensures consistent flow to the Second Stage of Multiple Economizers
- Size Based on Specified Pressure Drop and Boiler Flow Rate
  - Pressure Drop
    - Minimum: 5psi
    - Maximum: 20psi
  - Optional Sizes
    - 1/2" NPT (Cv = 26)
    - 3/4" NPT (Cv = 55)
    - 1" NPT (Cv = 110)
    - 1-1/4" NPT (Cv = 180)
    - 1-1/2" NPT (Cv = 270)
    - 2" NPT (Cv = 500)

Transmitters

- Water Temperature Transmitter 0-1000F
  - Recommend: (4) Four
- Gas Temperature Transmitter 0-1000F
  - Recommend: (2) Two

Controls

- CEC-10x (x − Specifies the Number of Boilers)
  - Utilized for (1) Economizer or Retrofit Applications
  - LCD Text Display
- CEC-20x (x − Specifies the Number of Boilers)
  - Utilized for 1 – 4 Economizer Application
  - LCD 6" Touch Color Display
- Hawk
  - Utilized for (1) Economizer Application
  - Existing or New Hawk can be Utilized

Vent Extension

- Only Required for CBLE, 4WI, and CBR boilers.
- 2000lb. 12" Vent Stub Extension
- Available for 70HP to 800 HP
- Additional support is needed to completely secure an Economizer

12" 2000lb. Vent Extension (Equivalent Horsepower)
70 HP to 100 HP
125 HP to 225 HP
250 HP to 350 HP
400 HP to 800 HP

Outdoor Coat – Paint

- Required for outdoor insulations

Economizer Supports

- Option available within the Firetube Program (Tab: Pressure Vessel)

ASME Stamp / CRN

- ASME National Board "UM"
  - Standard
- ASME National Board Stamp – Sec. VIII; Div. I ('U')
  - Optional
  - Required (Water Volume is larger at the specified Design Pressure)
    - 1-1/2 ft^3 @ 600psi (Design Pressure)
    - 3 ft^3 @ 350psi (Design Pressure)
    - 5 ft# @ 250psi (Design Pressure
  - ASME National Board Stamp – Sec. I ('S')
    - Optional
  - CRN (Must Specify CRN Province)
    - Optional

International Orders

- Ship to Thomasville
- Export Packaging

Other offerings

- CRE or CCE
  - Single Stage (Non-Condensing) Economizer
  - Boiler Feedwater, Hot Water Return, Make-Up Water
- C1X
  - Single Stage Condensing Economizer
  - Process or Make-Up Water
  - Hot Water of Low Pressure Steam Application

TWO STAGE (C2X) BOILER EXHAUST ECONOMIZER SPECIFICATIONS

1.0 GENERAL DESIGN

1.1 Furnish and install an exhaust gas economizer in the exhaust duct of the boiler in accordance with the following specifications as designed and manufactured by Cain Industries, Inc.

1.2 The economizer shall be a light weight design for easier installation, rectangular, and manufactured and tested in accordance with the requirements of Section VIII, Division I of the ASME Boiler and Pressure Vessel Code.

1.3 The economizer shall have two liquid circuits. The circuit closest to the entering exhaust gas shall be used to preheat boiler feedwater. The circuit closest to the exiting exhaust gas shall be used to heat boiler make-up water or process water.

1.4 The economizer shall be designed to include as standard, an internal, high temperature heat resistant design Flue Gas By-pass Diverter to provide for: emergency by-pass, requiring no additional duct work for controlling either:
A. Stack Corrosion B. Turn Down Performance C. Excessive flue gas back pressure due to fouling

1.5 The Economizer shall have a hinged, full face, gas tight, inspection door, providing access to the heating surface for inspection and/or cleaning.

1.6 The Economizer must be completely drainable when mounted in the vertical position or horizontal position.

1.7 Header manifolds for low liquid flow pressure drop shall be provided. The liquid header manifolds shall also contain 3/4" NPT connections for venting, draining, and/or safety relief valves as required.

1.8 Compression fitted Al-Fuse fin tubes shall be connected to header manifolds for ease of tube replacement requiring no welding.

2.0 CONSTRUCTION

2.1 Feedwater section: Design Pressure: 300 psig @650°F.; Test Pressure: 450 psig; Max. Flue Gas Inlet Temperature: 750°F.

2.2 Make-up water section: Design Pressure: 150 psig @550°F.; Test Pressure: 225 psig; Max. Flue Gas Inlet Temperature: 750°F.

2.3 Fins: pitch 6 Fins/In. Max.; Material: Aluminum; Thickness: .020"; Height: .50"; Alfuse metallurgically bonded to the tube.

2.4 Tube: outside diameter: 1.0"; Wall Thickness: .065"; Material: TP316 Stainless steel ERW

2.5 The Feedwater header manifolds are constructed of carbon steel. The make-up/process water header manifolds are constructed of 304 stainless steel. All of the make-up/process water liquid side surfaces are stainless steel.

2.6 2" thks. 1000°F thermofiber factory installed, high temperature insulation shall cover the shell less the header assemblies and stack adapters.

2.7 Exterior surfaces shall be 12ga. 304 stainless steel and shall be primed and painted with a high temperature metallic paint rated for 1000°F. The inner shell shall be 304 stainless steel.

2.8 (2) Stainless steel economizer to stack adapters are included.

3.0 OPTIONAL EQUIPMENT

4.1 (2) 50-500°F, bimetal, 3" adjustable dial, water temperature thermometers with wells.

4.2 (2) 50-300°F, bimetal, 3" adjustable dial, water temperature thermometers with wells.

4.3 (2) 150-750°F Bi-metallic flue gas temperature thermometers, 3" dial.

4.4 (1) 300 psig safety relief valve.

4.5 (1) 150 psig safety relief valve.