Flue Gas Cooler, CO boilers and Heaters experience in FCC and RCC Units by Foster Wheeler

Huge quantities of low pressure flue gases containing carbon oxides (CO) are available in Refineries as a by product of the catalyst regeneration process in fluid catalytic cracking (FCC) and residue cracking (RCC) units.

This CO gas is utilised for steam production for three reasons:

- To recover the heat available in flue gases;
- To convert CO in CO_2 before discharging the flue gases to atmosphere;
- To lower the gas temperature prior to catalyst fine recovery devices.

Depending upon the regeneration process two types of heat recovery (i.e. fired boiler and unfired waste heat boiler) are available:

The first solution is common when carbon deposits on catalyst are removed with low excess air. The flue gases are rich in carbon monoxide to be converted to carbon dioxide before its discharge to atmosphere.

CO boiler design must take into consideration the three reasons mentioned above, i.e. recover the heat available, convert the CO to CO_2 and cooling for fines recovery. These equipment are not only boilers but also incinerators where residence time at high temperature is the key factor for the proper CO oxidation.

For the fired boiler two solutions are available.

- The typical design of natural circulation water-wall boilers where the radiant section is properly sized to provide the required residence time.

- The adiabatic type where oxidation of CO gas takes place in a combustor and the heat is fully recovered in a section by convection. The adiabatic type is utilised particularly when minimum but flexible steam production and high turndown capacity. This design also gives very stringent limitation on CO emission to atmosphere.

The second solution with flue gas cooler is used in cases where little or no CO is present in the flue gases (when fully converted in the catalyst regeneration process).

In addition to the above Foster Wheeler has engineered and built similar combustors with heat recovery to Crude, Vacuum and Feed Preheating service instead of steam generation.

Flue gas coolers are heat recovery units where sensible heat contained in the flue gases is utilised to produce and superheat steam or to preheat process oil streams for energy conservation purposes. The heat recovery section is composed either by horizontal or vertical bare tubes.

For this design Foster Wheeler solution has an efficient and simple device to collect the dust. The exchanging surfaces, being top supported and arranged in small groups of tubes with upper and lower headers, the gap available between the lower headers allows all of the dust, removed by soot-blowers, to fall down directly to the collecting hoppers. The bottom section of the heat recovery unit has collectors to allow a reliable and easy operation, as well as dust removal.

The above solution is proven extremely successful, particularly if compared to other boiler design types.

Foster Wheeler has designed in the past many similar CO Boilers, both boiler type and adiabatic combustor type up to 200 t/h steam capacity. In the recent years, boilers with steam capacity up to 500 t/h were designed and built.








A partial list of CO Boilers, Heaters and Flue Gas Coolers designed and built by Foster Wheeler is given hereto attached.

Date	Company and Location	Steam Capacity t/h	Type	Press. Bar	Temp. °C
2013	Petroecuador Esmeraldas (Ecuador)	31	FC u	42	400
2012	Lukoil Nizhegorodnefteorgsyntez Kstovo (Russia)	74	NC u	34	325
2011	Rosneft Syzran (Russia)	41	NC u	42	420
2010	CPC Ta-Lin (Taiwan)	492	NC f	47	400
2008	Valero Benicia/CA (USA)	CO Vacuum Fired Heater			
2008	Valero Benicia/CA (USA)	CO Crude Fired Heater			
2008	Saras Sarroch (Italy)	112	FC f	72	490
2008	Conoco Phillips Linden/NJ (USA)	106	FC f	55	388
2008	Lukoil Nizhegorodnefteorgsyntez Kstovo (Russia)	74	NC u	34	325
2006	Petrovietnam Dong-Quat (Vietnam)	293	NC f	45	258
2005	PDVSA Cardon (Venezuela)	145	FC f	18	360
2004	Ufaneftechim Ufa (Russia)	29	NC u	20	272
2004	Syncrude FortMcMurray/AB (Canada)	236	FC f	65	504
2004	Syncrude FortMcMurray/AB (Canada)	236	FC f	65	504
2003	RPC Concon (Chile)	24	FC u	42	400
2002	ConocoPhillips Ferndale/WA (USA)	68	FC f	33	329
2001	Exxon Mobil Altona (Australia)	Incinerator Only			
1998	Lukoil Permnefteorgsyntez Perm (Russia)	14	FC f	31	249
1997	Shell Port Dickson (Malaysia)	204	NC f	41	420
1996	BP Grangemouth (England)	79	NC u	40	330
1993	Pemex Salamanca (Mexico)	27	FC f	20	273

Flue Gas Cooler and CO Boiler Experience by Foster Wheeler

Date	Company and Location	Steam Capacity t/h	Type	Press. Bar	Temp. °C
1993	SRC Singapore	139	NC f	42	324
1992	Fina Raffinaderij Antwerp (Belgium)	160	NC f	71	427
1991	Pertamina Balongan (Indonesia)	213	NC f	40	350
1990	Shell Geelong (Australia)	145	NC u	40	420
1989	Shell Norco/LA (USA)	183	FC f	93	496
1989	Shell Oil Stanlow (England)	150	FC f	111	545
1988	Columbian Chemical Canada Ltd Hamilton/ON (Canada)	45.4	NC f	41	400
1986	Koch Corpus Christi/TX (USA)	136	FC f	29	343
1985	BP Rotterdam (The Netherlands)	22.7	NC f	27	346
1980	INA Rijeka (Yugoslavia)	68	FC f	14	300
1979	Carribean Gulf Refining Bayamon (Puerto Rico)	31.7	NC f	19	265
1977	Continental Carbon Co. Westlake/LA (USA)	2 x 25	NC f	45	400
1975	Petroleos Mexicanos Salamanca (Mexico)	200	NC f	59	482
1973	Petroleos Mexicanos Madero (Mexico)	300	NC f	19	293
1973	Imperial Oil Limited Edmonton/AB (Canada)	136	NC f	45	400
1973	Continex International Ltd. Grangemouth (UK)	3 x 16	NC f	18	210
1972	Carbesa La Linea (Spain)	2 x 10	NC f	18	260
1972	SIBP Antwerp (Belgium)	120	NC f	78	426
1972	Petrofina Canada Limited Ponte aux Trembles/QC (Canada)	59	NC f	18	271
1968	Crown Central Houston/TX (USA)	83	FC f	31	400
1967	Imperial Oil Limited Sarnia/ON (Canada)	250	NC f	45	400
1967	Mobil Oil Company Torrence/CA (USA)	137.4	NC f	86	454

Flue Gas Cooler and CO Boiler Experience by Foster Wheeler

Date	Company and Location	Steam Capacity t/h	Type	Press. Bar	Temp. °C
1967	SIBP Antwerp (Belgium)	67	NC f	70	415
1966	Petrofina Canada Limited Ponte aux Trembles/QC (Canada)	54.4	NC f	18	271
1966	Phillips Imperial Chemical Kurnell (Australia)	2 x 20	NC f	21	
1966	Shell Canada Ltd Montreal/QC (Canada)	59	NC f	15	315
1965	NCRA McPherson/KS (USA)	30.9	FC f	16	235
1964	BP Canada Limited Montreal/ QC (Canada)	45.4	NC f	45	446
1964	DX-Sunray Oil Company Tulsa/OK (USA)	85	FC f	31	304
1963	Gulf Oil Corporation Philadelphia/PA (USA)	182	FC f	47	364
1962	ANIC Sannazzaro (Italy)	51	NC f	16	260
1962	Sun Oil Company Markus Hook/PA (USA)	182	FC f	36	400
1962	Shell Deer Park/TX (USA)	CO Fired Feed Preheater			
1962	Shell Sarnia/ON (Canada)	CO Crude Fired Heater			
1962	Shell Norco/LA (USA)	CO Fired Feed Preheater			
1961	Pure Oil Company Smiths Bluff/TX (USA)	81	FC f	31	343
1960	Humble Oil & Refining Co. Bayway/NJ (USA)	182	FC f	48	382

Legenda:

NC / FC = Natural / Forced Circulation
f/u = Fired / Unfired