Clayton
INNOVATIVE STEAM SYSTEM SOLUTIONS

THE CLAYTON GUIDE TO STEAM GENERATION



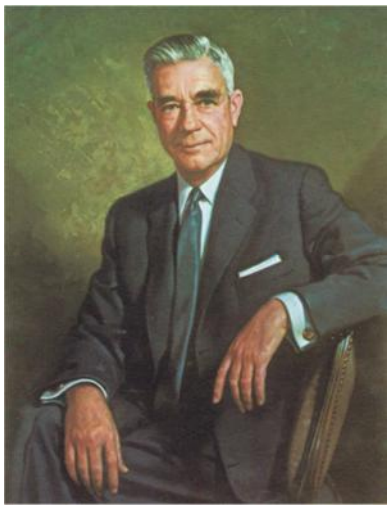

History

Clayton Steam Systems is a world leader in the design and manufacture of compact, high efficiency, rapid start steam systems that are safe to use and are of advanced designs.

The Clayton Company was founded in 1930 and reorganised under the name of the Clayton Manufacturing Company in 1935 to investigate and develop new concepts in thermodynamic and mechanical products. The Clayton Steam Generator was the first such product and was conceived as a packaged, force circulation coil steam generator that could automatically produce steam in five minutes from a completely cold condition.

The Clayton Steam Generator is of a unique design where high efficiency and rapid start-up are combined with high steam quality and fast response to changes in steam demand. In addition, the low blowdown requirement saves energy, water and treatment chemicals. The operating principle of the Clayton Steam Generator has eliminated the need to contain and heat large quantities of water. Consequently all generator models are small in size and weight and can be accommodated within a limited space.

One of the major safety advantages of the small water content is that there is no possibility of a steam explosion from a Clayton Steam Generator.



The energy saving features of the Clayton Steam Generator was of considerable interest to William Clayton who was concerned with fuel conservation long before the modern day awareness and effects of energy use.

The Clayton Exhaust Gas Boiler operates on the same tried and tested principles and has been produced to satisfy a variety of industrial and marine applications to recover heat from waste gas.

Designs are continually being improved and developed as well as being upgraded to incorporate the latest engineering technology and techniques. The range of sizes has been added to over the years and it is now no longer necessary to use the traditional fire tube boiler for outputs in excess to 60 tonnes of steam per hour.

The many advantages of the designs make Clayton Steam Systems ideally suitable for any steam application.

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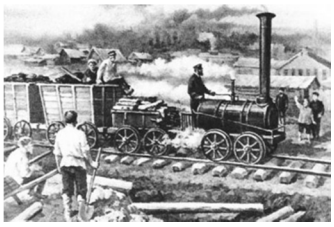
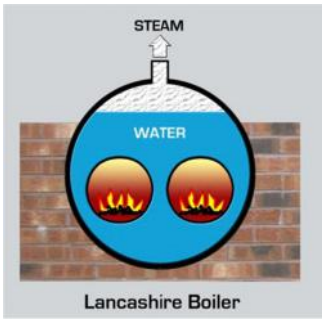
The Old Steam Age

Steam was the driving force during the days of the industrial revolution and was used to power the giant textile mills, steam trains and ocean going ships of the time.



In those days steam boilers were just like the common domestic kettle where a volume of water is heated in a container and steam is ejected through the spout.

One such steam boiler design was the famous Lancashire Boiler that was the most advanced of it's time. In this boiler coal was used as fuel to heat two 'firetubes' which in turn heated the water that surrounded them. As the temperature of the water rose, steam bubbled off the water surface and into the steam pipe.



However one of the many drawbacks of the old firetube design was the explosion hazard that caused death and serious injury with alarming frequency. These tragedies were regarded as acts of god in those days but we now know that they were a consequence of this particular method of steam production. The hot water is stored inside a firetube boiler at the same pressure as the steam and a failure of the outer casing will cause the water to expand to around 1600 times its volume in less than a second - causing a devastating explosion. This is most likely to happen when the water level in the boiler drops to a dangerously low level.

It's not difficult to imagine the second disadvantage which is the time it takes to heat up in the first place. This is measured in hours rather than minutes because the large mass of steel and water must first be heated before the steam pressure can build up. This means that boilers had to be started well in advance of when they were needed - or had to be kept ticking over so that they were available when steam was required. The inherent lag in response also meant that the boiler had to be large enough in size to cater for varying outputs.

These old boilers are early versions of the firetube boilers that are the horizontal cylindrical shape we still recognise today. Improvements in the firetube design have, of course, been made where possible.

But why didn't someone come up with a different method of producing steam that does not have all of these disadvantages? - Well Someone Did!

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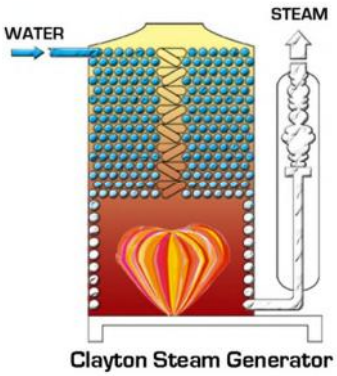
The New Steam Age

Instead of heating a large amount of water and steel - heat a small amount of water and steel.



Clayton Steam Generator

This is possible by pumping water through the inside of a small diameter heated coiled tube so that cold water goes in one end and high pressure steam comes out the other. The Clayton Steam Generator is a unique design that does just that. Instead of the familiar steam train image of a boiler we now have a compact steam making machine with staggering advantages for the world we live in today.

The Clayton Steam Generator uses only three main components. These components are a special pump, a special water tube coil and a special steam separator. Water is heated as it is pumped through the coil and it is then fed to the to the steam separator to produce very high quality dry steam.

So all of the momentum from the heavy steel and large volume of water has been eliminated which means that the boiler is small in size and will start-up in five minutes from the flick of a switch. The response is more like a racing car than an oil tanker when it's running because the steam flow is synchronised with the speed of the pump and the heat source - so it can ramp up and down in seconds with unrivalled fuel efficiency. And when it is not needed at the end of the working day it can be switched off with the lights to conserve energy.

The basic operating principle produces one advantage that leads to another and another. These are not limited to the quick start-up, rapid response, small size, low weight, low running cost automatic operation, and reliability.

Many people consider that the main advantage of the Clayton Steam Generator compared to a firetube boiler is that safety has taken a great leap forward. This is because there is no possibility of a steam explosion. It is not even necessary to check the water level – because there isn't one. So the peril that was a constant danger once-upon-a-time has now been completely eliminated. In fact the Clayton Steam Generator can run without operator attendance even at very high steam pressures and temperatures.

Most of the world forward looking companies and institutions that use steam in their production or process already operate Clayton Steam Generators.

The traditional horizontal cylindrical boilers image that made history has now made way for high powered vertical Clayton Steam Generator of today.

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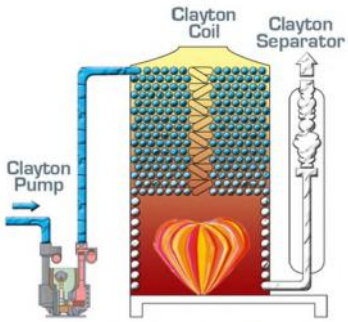
Principle of Operation

The Reason for the many advantages of the Clayton Steam Generator is the Forced Circulation Monotube Coil Concept. This operates on a simple but ingenious principle.



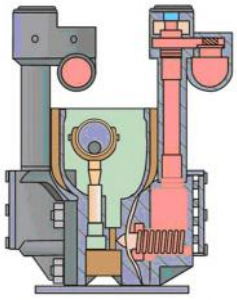
The boiler feedwater is pumped by means of a specially designed Clayton Pump and is forced through a single heating coil from the top to the bottom. The steam/water mixture from the outlet of the coil is then passed to a high efficiency centrifugal separator. Steam quality from a Clayton Steam Generator is up nearly completely dry saturated and the separated water is re-cycled.

The Clayton Coil is of a unique design that has been developed for optimum heat transfer at all steam output levels.

The coil is a single water tube which is stacked in spirally wound layers in the upper section and forms a 'water wall' around the combustion chamber of the lower section. The configuration of the coil as well as the variation in the tube diameter, spacing between layers and spacing between tube turns in different temperature zones of the coil are all carefully designed to maximise efficiency and prevent hot spots.

The spiral construction of the coil is extremely robust and counteracts the effects of expansion during rapid heating and cooling. In the case of oil fired units, sootblowing facilities are provided to remove deposits from the outside of the coil while the unit is in operation to keep it running at maximum efficiency.

The Clayton Pump is of a remarkable design and is manufactured specifically to provide the forced circulation through the coil of a Clayton Steam Generator.



The pump is a positive displacement type that ensures flow stability over a wide range of varying pressure conditions. The Clayton Pump does not rely on mechanical seals, packing rings or glands to separate the water being pumped and the drive mechanism. Operation is completely unaffected by high water temperature and the construction of the Clayton Pump is extremely robust, very reliable and low in maintenance.

On every Clayton Steam Generator the pumping rate is synchronised to the burner firing rate so that the steam output can be ramped up and down as required.

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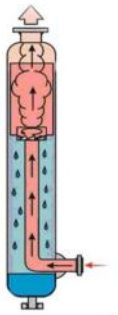
Principle of Operation

The Clayton Steam Separator is a high efficiency centrifugal design that has no moving parts. The very high steam quality is produced even under variable load conditions and is at least 99.5% dry saturated.

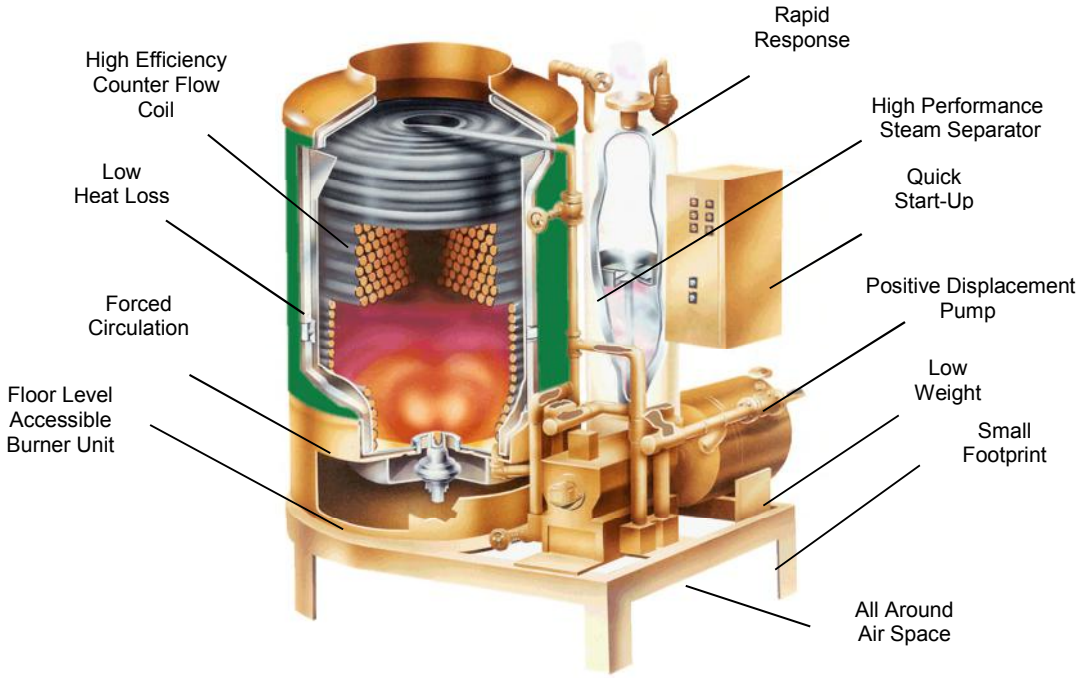


The steam/water mixture from the Clayton Steam Generator is directed to the inlet of the separator where it is directed over a series of vanes and separated by means of centrifugal force. The water is collected and dry steam is discharged through the top outlet. The blowdown from a Clayton Steam Generator is extremely low since this is taken from the water collected by the separator.

The Clayton Burner is specially designed to ensure that the flame is confined to the combustion chamber and that combustion is complete before the hot gasses are released over the coil.

To achieve this, the air for combustion enters the burner manifold at high velocity where it picks up fuel in a whirlpool action to form a heart shaped flame where the flame tip folds over into the low pressure zone. Fuel and air are blended in precise ratios and the burner fires upwards, which is the natural direction for heat.

The Clayton Advantage



Benefits

Very high efficiency is the most obvious benefit that comes from small sizes because of the low heat losses. Heat flow is upwards - in the opposite direction to the water flow - and this optimises heat transfer and results in low running costs.

Start up from a completely cold condition is five minutes. Warm up fuel is minimised and the unit can be switched off when not required. The Clayton Steam Generator is therefore also ideal when used as an auxiliary or standby boiler

Steam quality is the best available from any type of boiler and is at least 99.5% dry saturated at all steam loads. This reduces the amount of water and impurities going into the steam line and ensures higher energy content of the process steam.

Blowdown which is necessary to prevent the build up of impurities in all types of boiler is extremely small with the Clayton design. This saves fuel, saves chemicals and saves water.

Because of the inherent safety and automatic systems all Clayton Steam Generators can be supplied to run without operator attendance for up to a period of one week if the unattended control option is included.

The compact size means that minimal space is required for a complete boiler house. Building costs are reduced and a Clayton system can easily be fitted into the available area. The light weight even allows location on an upper floor level.

It is not possible to have a steam explosion. This is a danger associated with low water level in other types of boiler that store a large volume of hot water. The Clayton Steam Generator does not have a water level and does not store a large volume of water.

Extremely rapid response to changes in the demand for steam is inherent in the forced circulation design. A Clayton Steam Generator will speedily ramp up or run at maximum steam output continuously without faltering.

The rapid start and rapid response can be controlled automatically. All Clayton systems can be started by a single switch locally or remotely just like any modern advanced machinery - if the automatic start option is included.

One of the practical benefits of the simple design concept is that maintenance requirements are minimal. The technology has been developed and improved over many years to make the Clayton Steam Generator the most reliable steam boiler available today.

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Safety

Unless you have experienced a firetube boiler explosion personally it is hard to imagine the enormous destructive potential of steam. In a firetube boiler (shell boiler) a large mass of water is stored in a cylindrical vessel and heated to form steam. A faulty firetube boiler is just like a time bomb. It can produce a near instantaneous, uncontrolled, release of energy.

Fortunately, due to government legislation and established design codes as well as proper operator training and sophisticated control systems these explosions are now much less frequent than in days gone by. But there can be no cast iron guarantee that a disaster will not occur.

Overheating caused by low water is the most frequent cause of boiler explosions, or other damage. The most important job of the firetube boiler operator is to make sure the water level is correct at all times. In contrast a Clayton Steam Generator does not have a water level and it is not possible to have a steam explosion with the Clayton design.|

Clayton famously demonstrated this when they tested ***a 500 boiler horsepower steam generator to destruction after removing all of the safety devices*** *from the unit. This demonstration took place in front of an invited audience, including inspectors from the Technical Standards and Safety Authority of Ontario, Canada. The test was recorded on video.*

The operating principle of the Clayton Steam Generator is very different from that of the firetube boiler. A firetube boiler uses natural convection for heat transfer and subsequently it must store a large amount of energy in the form of high pressure hot water.

The Clayton Steam Generator, by comparison, uses forced circulation of water though a helical coil which is heated to produce steam. It follows therefore that there is relatively little water in a Clayton Steam Generator contained within the coil.

Even if the coil of a Clayton Steam Generator is damaged in any way this cannot produce a dangerous condition.

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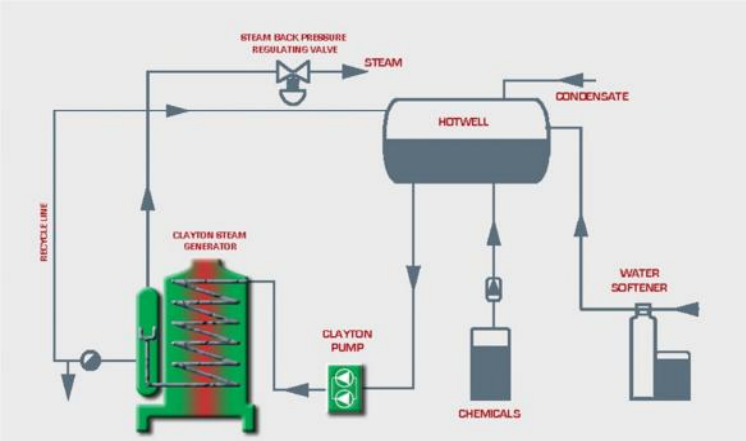
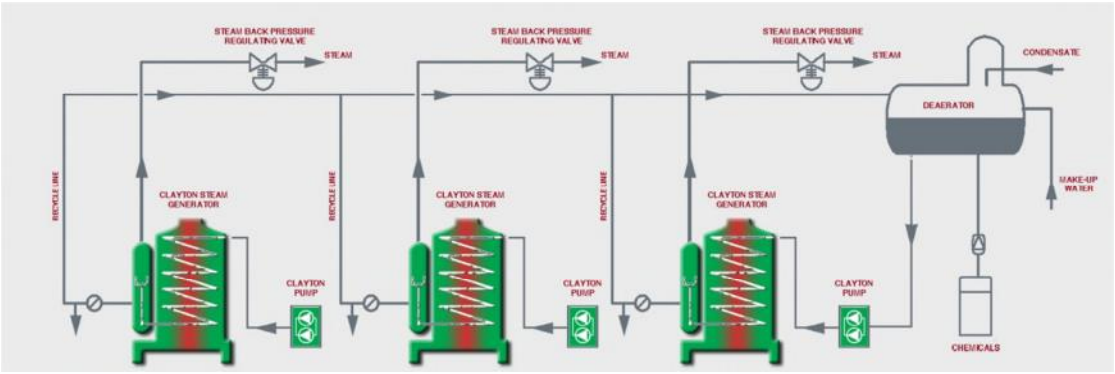
Steam Systems

Systems and equipment that ensure trouble-free operation of the steam generating plant are designed with the same Clayton experience and expertise. Clayton offers a range of ancillaries and packages to match the selected steam generators and manufactured to the same high standards.



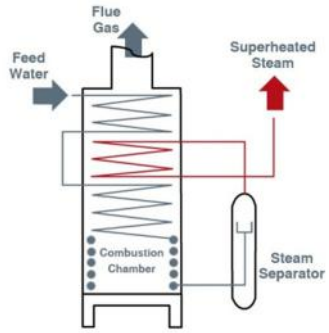
The most common system is the Clayton Open System in which condensate can be returned at atmospheric pressure. In the Open System, boiler feedwater is directed from an atmospheric Hotwell to the Clayton Pump and is fed to the Clayton Steam Generator. Steam flows from the Clayton Steam Separator outlet nozzle through a backpressure regulating valve and the condensate from the separator is re-circulated back to the hotwell. The small amount of blowdown required on a Clayton Steam Generator is taken from the recirculation line. The make-up water supply can be passed through a water softener and chemicals can be dosed directly into the hotwell.



On multiple Clayton Steam Generator installations the feedwater equipment is common to all. Other tried and tested designs include the Clayton Closed and Semi-Closed Systems that are used where energy savings from condensate heat recovery is required.

Steam Systems

High Pressure and Superheated Steam supply is another application where the design of the Clayton Steam Generator is perfectly suited. The small diameter water tube coil allows steam pressures of up to 200 barg to be produced and the helical heat exchanger concept means that superheated steam can be generated up to temperatures of 460 degrees centigrade.



The spiral construction of the Clayton heating coil means that it is extremely robust and will counteract any effects of expansion and contraction during rapid heating and cooling cycles without experiencing any mechanical damage.

On Superheated Clayton Steam Generators the feed water is directed to the topmost layer of coil where it is pre-heated as it spirals downwards and fed to the lower section from where it passes to the high efficiency steam separator. Dry steam from the separator is then directed to the integral superheating coil section where the desired steam temperature is produced.

Power Stations have benefited by using the Clayton Steam Generator where superheated steam, high pressure steam and rapid start capability combined with the inherent safety have particular benefits. In both conventional and nuclear power stations the Clayton Steam Generator is used for peak shaving, auxiliary start-up steam, back-up steam supply and emergency steam.

When used as an auxiliary start-up boiler the Clayton Steam Generator enables a power plant to be brought on-line rapidly which means lower emissions, less fuel consumption, less water consumption, less chemical consumption, less electricity consumption and provides increased revenue as well as the commercial advantage that comes from having the flexibility of being able to start-up quickly.

Marine & Offshore Steam Systems are ideal applications where the safety, space saving, unmanned operation, reliability and modular construction have made Clayton the offshore standard for ships and offshore oil platforms. The Clayton Marine Steam Generator is type approved by many marine authorities and can be supplied to the requirements of any inspection agency.

Clayton's own marine standard includes specified materials, control systems, electrical motors, cabling, tagging, documentation and other essential features required in this demanding industry.

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Ancillary Equipment

Clayton Hotwells are designed to perform several essential functions. The Clayton Hotwell provides feedwater for the Steam Generator acts as a reservoir for returned condensate and is an ideal means of blending water treatment chemicals. An important feature of the Clayton hotwell is that it is a partial deaerator capable of removing most of the oxygen - which is the major cause of corrosion in feedwater. The hotwell is steam heated to maintain a controlled temperature of around 90 to 95^{O}C and the residence time is calculated to ensure that the oxygen level is significantly reduced.

Clayton Hotwells are available as either horizontal or vertical vessels. All are supplied complete with special inducer tubes, temperature control, automatic level control and automatic filling. For large steam flows, high pressure steam or superheated steam system the Clayton Thermal Deaerator may be recommended.

Clayton Back Pressure Regulating Valves can be provided with each steam generator to control the minimum pressure of the generator in response to the pressure sensed by an impulse line on the downstream side. The purpose of the valve is to ensure stable operation under fluctuating loads and is used as part of the Clayton Automatic Start System.

Clayton Chemical Dosing Systems will maintain the correct water quality which is a requirement of all types of steam raising plant. The systems incorporate a chemical storage tank which is sized for the Clayton Steam System and micro-processor controlled diaphragm chemical injection pump to accurately meter the amount of chemical used. The chemical dosing system will ensure long life of the equipment.

Clayton Water Softeners are of the automatic ion-exchange type that remove hardness from the raw feedwater. Because water softeners must be periodically regenerated these are available as single (simplex) units on plants where the Clayton Steam Generator will be off during regeneration and as double (twin) units for continuous or long running periods of the Clayton Steam Generator.

Regenerations of simplex water softeners are instigated on an operator-set time basis and twin softeners are fitted with a micro-processor which allows regeneration to take place in proportion to water usage.

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Ancillary Equipment

Clayton Water Test Kits provides a simple and practical means of measuring the quality of the feedwater supply to the Clayton Steam Generator. The kit includes the necessary equipment to carry out tests for water hardness, levels of oxygen scavenger, dissolved solids and pH.

Full instructions for use are included with the kit and a Clayton Feedwater Treatment Manual is available which provides information on the water quality required and how this is achieved.

Clayton Booster Pumps will ensure that the minimum net positive suction head is maintained for the main Clayton Pump where the hotwell is mounted at low level. Booster pumps are selected to suit the generators being supplied.

Clayton Blowdown Vessels are designed to safely handle the discharges from the automatic or manual blowdown systems on the Clayton Steam Generator. Blowdown vessels can also be supplied with discharge cooling systems if required.

Clayton Water Treatment Chemicals are specially formulated to maintain the correct water conditions to protect the Clayton Steam Generating System. The use of these chemicals will guarantee trouble free operation and long life of the equipment. Chemicals are available in powder or liquid form and are easily dosed using the Clayton Chemical Dosing Systems.

Skid Mounted Boiler Rooms

Clayton Steam Generator Systems can be supplied as separate modular units for installation on site or supplied as pre-assembled packages - or even as complete Skid Mounted Boiler Rooms which save installation time and on-site costs.

Each package is compact, easily transported and quickly installed. The systems can be supplied from our standard range or specially built to the customers' requirements. Fully automatic control can be included as well as monitoring devices, feedwater conditioning and all the necessary fittings, pipework and electrical wiring.

Feedwater Treatment Skid

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Containerised Boiler Rooms

The Clayton Containerised Boiler Room is a completely weatherproof steam supply system that can be quickly connected on site and easily re-located when required. The small size of the Clayton Steam Generator makes it ideal for this type of construction and systems can be supplied as standard or custom built designs.

All containers are of a heavy duty, weatherproof construction and customised with openings, flooring, bracketing and doors as necessary to suit the application. The Clayton Steam Generator, along with other Clayton ancillary equipment such as the hotwell tank, water softener, blowdown tank, chemical dosing system, valves, controls, instrumentation, pipework and electrical wiring is installed by our specialist factory technicians and all equipment used is of the highest quality.

Some of the options that are available include, aluminium flooring, insulated walls, acoustic air intake dampers, automatic combustion air dampers, frost protection, cooling, lighting, fire protection and wall insulation. The outer surface of the container is shot blasted and coated with an epoxy paint system with a final colour of the customer's choice.

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Range of Sizes

The Clayton Range of Steam Generators are suitable for all steam application and can run on natural gas, LPG, light oil, heavy fuel oil and are available as duel fuel oil/gas versions.

Very high steam pressures are available on standard models and special models that provide steam pressures up to 200 barg can be supplied in most sizes.

Other options include superheated versions, economiser sections to improve efficiency even further, low NOx models as well as marine and offshore versions.

Model Reference	Steam Flow (kg/hr)*	Max Load (kW)
E10	157	98
E15	235	147
E20	313	196
E26	407	255
E40	626	392
E50	783	490
E60	939	589
E80	1253	785
E100	1566	981
E125	1957	1226
E154	2349	1471
E185	2897	1815
E204	3131	1962
E254	3914	2432
E304	4697	2943
E354	5480	3433
E404	6263	3924
E504	7829	4905
E604	9394	5886
E704	10977	6868
E1004	15657	9809
E1104	17223	10790
E1204	18788	11771
E1304	20354	12752
*F&A Values		

More details are shown in the data sheets.

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Exhaust Gas Boilers

The Clayton Exhaust Gas Boiler was developed following the success of the Clayton Steam Generator and the design is based on the same tried and tested operating principle. This results in an Exhaust Gas Boiler of small size and weight that can produce steam of very high quality.

An added advantage of the Clayton Forced Circulation Monotube Coil Concept is that is not necessary to rely on any type of fins on the tube surface to assist heat transfer and this reduces the possibility of clogging with exhaust gas deposits. The configuration of the Clayton plain coiled tube is designed to maximise performance and allow free flow of hot gas over the tube in the opposite direction to the water flow in a counterflow pattern for maximum efficiency.

Due to the small size and weight of the Clayton Exhaust Gas Boiler a number of installation options are possible and the boiler can be fitted into the exhaust gas ductwork to suit the client's requirements.

The Clayton Exhaust Gas Boiler can produce steam using the heat in the waste gases from diesel engines, small gas turbines, incinerators, glass furnaces, enamel ovens, stress relieving ovens and other suitable applications.

On marine installations the Clayton Exhaust Gas Boiler has been used extensively for over 40 years to recover heat from the exhaust of main propulsion and power generating diesel engines. On-board ships a separate oil-fired Clayton Steam Generator is often supplied in conjunction with the Clayton Exhaust Gas Boiler for use when the vessel is in port.

Diesel engines on electrical generators of sizes up to 15 MW of electrical power are ideal for heat recovery using the Clayton Exhaust Gas Boiler these include light and heavy oil fired engines, gas fired engines and dual fuel units of 4-stroke and 2-stroke design.

Heat can be recovered on gas turbines up to 15MWe

The Clayton Exhaust Gas Boiler is also ideally suitable for many other applications depending on flow and temperature.

Clayton
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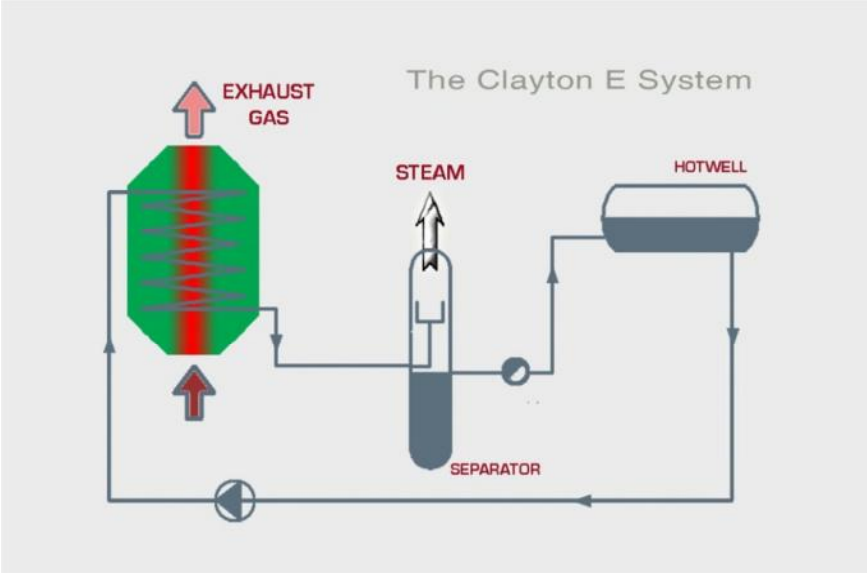
Exhaust Gas Boilers

Construction of the Clayton Exhaust Gas Boiler is modular and a range of standard coil sections have been developed to suit a wide variety of process conditions. The sections are chosen for optimum performance by computer programme, based on the heat available, the steam output required and the allowable pressure drop.

Because of the modular construction of the Clayton Exhaust Gas Boiler the assembly is a straightforward matter since the standard coil sections are bolted together and coned transition pieces are then added onto each end for connecting to the exhaust ducting. The water connections between each section are made on the outside of the boiler shell and an effective sootblowing system is built into every Clayton Exhaust Gas Boiler.

Clayton Exhaust Gas Systems have been devised to suit numerous processes. On all designs the water is pumped through the steam generating coil and the steam/water mixture produced at the outlet of the boiler is directed to a vortex separator which can be housed in a separator or accumulator.

More than one Clayton Exhaust Gas Boiler can be connected to a single accumulator. A feature of every system is that means are provided to avoid dew point corrosion of the tubes to prolong the life of the boiler.



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Customer Care

Service for Clayton Steam Generators and Exhaust Gas Boilers is available worldwide in more than 100 countries to provide commissioning, preventative maintenance, and advice to customers. Clayton operate round-the-clock service **24 hours a day, seven days a week and 356 days a year**.

Our after sales service is second to none and all of our engineers are dedicated trained specialists for all Clayton products. In addition all engineers are fully trained and certificated and are familiar with site-safety practices and permit-to-work systems.

Advice on installation requirements is available from Clayton engineers and our comprehensive installation manual gives general guidance to installers. Electrical and mechanical drawings are also provided for every unit.

Preventative Maintenance Contracts are arranged for many of our customers and these are based on regular visits by our engineers to carry out scheduled maintenance tasks to ensure optimum performance and efficiency. Our engineers are also available for strip-down and refit work associated with insurance inspections. Service contracts can be tailored to suit customers requirements and can range from labour only contracts to complete parts and labour maintenance contracts.

Commissioning services are available for equipment on-site and Clayton engineers carry out all necessary safety and operational checks and full commissioning services. Operator training is also available and customised training courses can be arranged if required.

Spare Parts are held in stock in many areas of the world and these are available for immediate despatch. Any spare can be provided based on our comprehensive records of every unit supplied. We can also advise on customer spare stocking policy to minimise downtime if required.

Training on Clayton Steam Systems can be seminar format or site based, hands-on instructions. The main topics include operating principle, water/steam/fuel system, safety precautions, electrical system, routine maintenance, fault diagnosis, water testing and regular checks. The content of the course can be varied to suit the level of competence of the participants. Technical literature is also provided and a certificate is issued to each student.

Clayton
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Clayton Worldwide

Clayton Steam Systems is a worldwide company with four manufacturing and a vast network of subsidiary companies and distributors throughout the Globe.

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Clayton
INNOVATIVE STEAM SYSTEM SOLUTIONS

TECHNICAL SPECIFICATIONS Sheet 1 - 10 to 185 BHP

GENERATOR MODEL			UNIT	E-10	E-15	E-20	E-26	E-40	SE-40	E-50	SE-50	E-60	SE-60	E-80	SE-80	E-100	SE-100	E-125	SE-125	E-185	SE-185
NET OUTPUT	MAXIMUM LOAD		kW	98	147	196	255	392	392	490	490	589	589	785	785	981	981	1226	1226	1815	1815
	FIRING STEPS		%	ON/OFF burner				50 / 100	50 / 100	50 / 100	50 / 100	50 / 100	50 / 100	50 / 100	50 / 100	50 / 100	50 / 100	50 / 100	50 / 100	50 / 100	50 / 100
EQUIVALENT MAXIMUM OUTPUT SATURATED STEAM (*)			kg/h	157	235	313	407	626	626	783	783	939	939	1253	1253	1566	1566	1957	1957	2897	2897
NOMINAL OPERATING STEAM PRESSURE			barg	Up to 150 barg depending on model and application																	
STANDARD INSTALLED ELECTRICAL MOTOR POWER (230/400/415/440 VAC - 50/60 Hz)	WATER PUMP		kW	0.37	0.37	0.55	0.55	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	4.2	4.2	5.5	5.5
	BLOWER		kW	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	3	3	5.5	5.5	5.5	5.5	5.5	5.5	11	11
COMBUSTION EFFICIENCY (**)	FUEL TYPE: G(Gas) O (Light Oil)			G O	G O	G O	GAS	G O	G O	GAS	GAS	G O	G O	G O	G O	G O	G O	G O	G O	G O	G O
	@ 100% STEP		%	94 93	91 92	92 92	90	91 92	94 95	88	93	91 91	94 94	92 93	95 96	92 93	95 96	91 92	94 95	90 91	94 94
	@ 50% STEP		%	ON/OFF burner				94 95	96 96	93	95	94 93	95 95	95 95	97 97	95 95	97 97	94 95	96 97	94 94	96 96
CONSUMPTION @ FULL LOAD	GAS - LCV 37000 kJ/Nm³		Nm3/h	10.2	15.7	20.7	27.6	42.0	40.6	54.2	51.3	62.9	60.9	83.0	80.4	103.7	100.5	131.1	126.9	196.2	187.8
	LIGHT OIL - LCV 42700 kJ/kg		kg/h	8.9	13.5	18.0		36.0	34.8			54.5	52.8	71.1	68.9	88.9	86.1	112.4	108.8	168.1	162.8
WATER CONTENT	FILLED		L	24	24	50	50	65	76.5	65	76.5	104	130	192	235	192	235	192	235	296	367
(generator water/steam system	IN OPERATION		L	9.1	9.1	14	13	20	30.4	20	30.4	25	33	47	61	47	61	47	61	84	108
HEATIING SURFACE			m²	4.5	4.5	5.1	5.1	7.8	11	7.8	11	10.7	15.8	19.1	27.5	19.1	27.5	19.1	27.5	25.1	37.1
GAS PRESSURE REQUIRED @ INLET (**)			mbarg	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
OVERALL GENERATOR DIMENSIONS (approx.)	LENGTH	gas	mm	1325	1325	1325	1325	1520	1520	1520	1520	1846	1846	2030	2030	2030	2030	2030	2030	2185	2185
		oil	mm					1325	1325			1570	1570	1755	1755	1755	1755	1755	1755	1885	1885
	WIDTH	gas	mm	960	960	1045	1045	945	945	945	945	1240	1240	1300	1300	1300	1300	1300	1300	1415	1415
		oil	mm	835	835	925															
	HEIGHT	gas - oil	mm	1470	1470	1890	1890	2150	2465	2150	2450	2320	2320	2405	2700	2405	2700	2405	2700	2515	2935
	WEIGHT (empty)	gas	kg	390	390	450	450	660	790	660	790	1000	1070	1725	1980	1725	1980	1725	1980	2000	2315
		oil	kg									965	1035	1725	1980	1725	1980	1725	1980	1910	2225
OVERALL PUMP SKID DIMENSIONS (approx.)	LENGTH		mm	500	500	515	515	930	930	930	930	1345	1345	1345	1345	1345	1345	1345	1345	1350	1350
	WIDTH		mm	375	375	465	465	630	630	630	630	680	680	677	677	677	677	677	677	820	820
	HEIGHT		mm	650	650	650	650	1065	1065	1065	1065	1025	1025	1025	1025	1025	1025	1025	1025	1155	1155
	WEIGHT		kg	40	40	40	40	180	180	180	180	325	325	325	325	325	325	325	325	400	400
GENERATOR STACK CONNECTION (outer diameter)			mm	202	202	202	202	305	305	305	305	381	381	457	457	457	457	457	457	559	559

NOTES

(*) @ 1 bara (absolute) with feed water temperature of 100 °C

(**) based on feed water temperature of 60 °C

(***) to be regulated by customer, based on 100% capacity and GAS-LCV as shown above.

TS-10 to 185 Rev C

TECHNICAL SPECIFICATIONS Sheet 2 - 150 to 500 BHP

GENERATOR MODEL			UNIT	E- 154		SE- 154		E- 204		SE- 204		E- 254		SE- 254		E- 304		SE- 304		E- 354		SE- 354		E- 404		SE- 404		E- 504		SE- 504	
NET OUTPUT	MAXIMUM LOAD		kW	1471		1471		1962		1962		2452		2452		2943		2943		3433		3433		3924		3924		4905		4905	
	MODULATION RANGE		%	33 / 100		33 / 100		25 / 100		25 / 100		20 / 100		20 / 100		20 / 100		20 / 100		20 / 100		20 / 100		20 / 100		20 / 100		20 / 100		20 / 100	
EQUIVALENT MAXIMUM OUTPUT SATURATED STEAM (*)			kg/h	2349		2349		3131		3131		3914		3914		4697		4697		5480		5480		6263		6263		7829		7829	
NOMINAL OPERATING STEAM PRESSURES			barg	Up to 150 barg depending on model and application																											
STANDARD INSTALLED ELECTRICAL MOTOR POWER (230/400/415/440 VAC - 50/60 Hz)	WATER PUMP (****)		kW	4		4		5.5		5.5		7.5		7.5		7.5		7.5		7.5		11.0		5.5 + 5.5		5.5 + 5.5		7.5 + 7.5		7.5 + 7.5	
	BLOWER		kW	5.5		5.5		7.5		7.5		11		11		11		11		15		15		22		22		30		30	
COMBUSTION EFFICIENCY (**)	FUEL TYPE G(Gas) O(Light Oil)			G	O	G	O	G	O	G	O	G	O	G	O	G	LO	G	LO	G	LO	G	O	G	O	G	O	G	O	G	O
	MAXIMUM LOAD		%	93	93	95	95	92	93	94	95	92	93	94	95	92	93	94	95	91	92	93	94	91	92	95	95	90	91	94	95
	MINIMUM LOAD		%	96	97	96	97	95	95	96	97	95	95	96	97	95	95	96	97	94	95	96	97	96	97	97	97	96	97	97	97
CONSUMPTION @ FULL LOAD	GAS - LCV = 37000	kJ/Nm^3	Nm^3/h	154		151		207		203		259		254		311		305		367		359		420		402		530		508	
	LIGHT OIL- LCV = 42700	kJ/kg	kg/h	133		131		178		174		222		218		267		261		315		308		360		348		454		435	
WATER CONTENT (generator water/steam system)	FILLED		L	556		695		556		695		556		695		777		916		777		916		1495		1721		1495		1761	
	IN OPERATION		L	315		460		300		450		288		431		400		530		380		520		665		930		650		920	
HEATING SURFACE			m²	41.7		59.9		41.7		59.9		41.7		59.9		55.2		73.4		55.2		73.4		83.9		111		83.9		111	
MINIMUM GAS PRESSURE REQUIRED @ INLET (***)			mbarg	160-240		160-240		210-360		210-360		190-280		190-280		230-365		230-365		280-450		280-450		190-250		190-250		250-340		250-340	
ATOMIZING AIR (oil fired only)	REQUIRED FLOW		Nm^3/h	36		36		27		27		27		27		32		32		32		32		40		40		40		40	
	REQUIRED PRESSURE		barg	5 --> 7		5 --> 7		5 --> 7		5 --> 7		5 --> 7		5 --> 7		5 --> 7		5 --> 7		5 --> 7		5 --> 7		5 --> 7		5 --> 7		5 --> 7		5 --> 7	
OVERALL GENERATOR DIMENSIONS (approx.)	LENGTH	gas	mm	2755		2755		2755		2755		2745		2745		2745		2745		2745		2745		3060		3060		3060		3060	
		oil	mm	2550		2550		2550		2550		2550		2550		2550		2550		2550		2550		2840		2840		2840		2840	
		gas-oil	mm	2882		2882		2882		2882		2872		2872		2872		2872		2872		2872		3190		3190		3190		3190	
	WIDTH	all fuels	mm	1950		1950		1950		1950		1950		1950		1950		1950		1950		1950		2130		2130		2130		2130	
	HEIGHT	all fuels	mm	2785		3165		2785		3165		2785		3165		2915		3490		2915		3490		3410		3975		3410		3975	
	WEIGHT (empty)	all fuels	kg	2950		3450		3050		3550		3150		3650		3600		4100		3700		4200		5800		6600		5800		6600	
OVERALL PUMP SKID DIMENSIONS (approx.)	LENGTH		mm	1345		1345		1350		1350		1350		1350		1350		1350		1350		1350		1350		1350		1350		1350	
	WIDTH		mm	680		680		820		820		820		820		820		820		820		820		820		820		820		820	
	HEIGHT		mm	1025		1025		1155		1155		1155		1155		1155		1155		1155		1155		1155		1155		1155		1155	
	WEIGHT		kg	325		325		400		400		400		400		400		400		400		400		400		400		400		400	
GENERATOR STACK CONNECTION (outer diameter)			mm	559		559		559		559		713		713		713		713		713		713		806		806		806		806	

NOTES

TS-154 TO 504 REV B

(*) @ 1 bara (absolute) with feed water temperature of 100 °C

(**) based on feed water temperature of 60 °C

(***) to be provided by customer (based on 100% capacity; based on LHV between 31,8 and 37,3 MJ/Nm³) - (Note: gas train design pressure is 500 mbar)

(****) motor power may vary due to feed water pressure. E404 and up have two pumps

TECHNICAL SPECIFICATIONS Sheet 3 - 600 to 1300 BHP

GENERATOR MODEL			UNIT	E- 604	SE- 604	E- 704	SE- 704	E- 1004	SE- 1004	E- 1104	SE- 1104	E- 1204	SE- 1204	E- 1304	SE- 1304
NET OUTPUT	MAXIMUM LOAD		kW	5886	5886	6866	6866	9809	9809	10790	10790	11771	11771	12752	12752
	MODULATION RANGE		%	20 / 100	20 / 100	20 / 100	20 / 100	20 / 100	20 / 100	20 / 100	20 / 100	20 / 100	20 / 100	20 / 100	20 / 100
EQUIVALENT MAXIMUM OUTPUT SATURATED STEAM (*)			kg/h	9394	9394	10960	10960	15657	15657	17223	17223	18788	18788	20354	20354
NOMINAL OPERATING STEAM PRESSURES AVAILABLE UP TO (**)			barg	Up to 150barg depending on model and application											
STANDARD INSTALLED ELECTRICAL MOTOR POWER (230/400/415/440 VAC - 50/60 Hz)	WATER PUMP (****)		kW	11 + 11	11 + 11	11 + 11	11 + 11	55	55	55	55	75	75	75	75
	BLOWER		kW	30	30	45	45	75	75	75	75	75	75	75	110
COMBUSTION EFFICIENCY (**)	FUEL TYPE G(Gas) O(Light Oil)			G O	G O	G O	G O	G O	G O	G O	G O	G O	G O	G O	G O
	MAXIMUM LOAD		%	91 91	94 95	91 90	93 92	92 91	96 95	92 91	96 95	92 91	96 95	92 91	96 95
	MINIMUM LOAD		%	96 97	97 97	92 91	94 93	94 93	95 94	94 93	95 94	94 93	95 94	94 93	95 94
CONSUMPTION @ FULL LOAD	GAS - LCV = 37000 kJ/Nm^3		Nm^3/h	629	609	734	718	1037	994	1141	1094	1245	1193	1349	1292
	LIGHT OIL- LCV = 42700 kJ/kg		kg/h	545	522	643	629	909	871	1000	958	1091	1045	1181	1132
WATER CONTENT (generator water/steam system)	FILLED		L	1917	2183	2109	2375	5501	6930	5501	6930	5501	6930	5501	6930
	IN OPERATION		L	1120	1386	1150	1350	2500	3750	2500	3750	2500	3750	2500	3750
HEATING SURFACE			m^2	112.4	139.4	126.9	154	257	378	257	378	257	378	257	378
MINIMUM GAS PRESSURE REQUIRED @ INLET (***)			mbarg	310-430	310-430	220-430	220-430	300	300	300	300	340	340	400	400
ATOMIZING AIR (oil fired only)	REQUIRED FLOW		Nm^3/h	40	40	40	40	50	50	50	50	60	60	70	70
	REQUIRED PRESSURE		barg	5 --> 7	5 --> 7	5 --> 7	6 --> 7	5 --> 7	5 --> 7	5 --> 7	5 --> 7	5 --> 7	5 --> 7	5 --> 7	5 --> 7
OVERALL GENERATOR DIMENSIONS (approx.)	LENGTH	gas	mm	3060	3060	3320	3320	4646	4646	4646	4646	4646	4646	4646	4646
		oil	mm	2840	2840	3100	3100	4646	4646	4646	4646	4646	4646	4646	4646
		gas-oil	mm	3190	3190	3320	3320	4646	4646	4646	4646	4646	4646	4646	4646
	WIDTH	all fuels	mm	2130	2130	2115	2115	2600	2600	2600	2600	2600	2600	2600	2600
	HEIGHT	all fuels	mm	4590	5235	5200	5845	5229	6153	5229	6153	5229	6153	5229	6153
	WEIGHT (empty)	all fuels	kg	6900	7700	8600	9400	17800	21300	17800	21300	17800	21300	17800	21300
OVERALL PUMP SKID DIMENSIONS (approx.)	LENGTH		mm	1350	1350	1350	1350	2600	2600	2600	2600	2600	2600	2600	2600
	WIDTH		mm	820	820	820	820	770	770	770	770	770	770	770	770
	HEIGHT		mm	1155	1155	1155	1155	877	877	877	877	877	877	877	877
	WEIGHT		kg	400	400	400	400	950	950	950	950	950	950	950	950
GENERATOR STACK CONNECTION (outer diameter)			mm	806	806	908	908	1000	1000	1000	1000	1000	1000	1000	1000

NOTES

(*) @ 1 bara (absolute) with feed water temperature of 100 °C

(**) based on feed water temperature of 60 °C

(***) to be provided by customer (based on 100% capacity; based on LHV between 31,8 and 37,3 MJ/Nm^3) - (Note: gas train design pressure is 500 mbar)

(****) motor power may vary due to feed water pressure. E404 / 504 / 604 and 704 have two pumps

TS-604 to 1304 REV A