

BOILER BLOW DOWN

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Boiler blow down is a subject about which it is difficult to obtain any real information but as it forms one of the losses (of money as well as heat) in the working of a boiler it is well worth study and control.

In manufacturing industries make-up water is liable to become very large, even as much as 75% of the feed. Processes may require direct live steam or pure hot condensate. Steam pipe ranges and steam using plant may be wide-spread and scattered, making it difficult to return drains and condensate to the feed tank. Large and sudden

an hour it has risen to 70,000 lb./hr. and on many occasions an increased draw of 40,000 lb./hr. is put on in ten minutes. The irregularities travel back to the boiler plant and chart Fig. 2 marked 170 STEAM shows the pressure in the main boiler range. Wherever the pen line touches the 168 lb. pressure line you may be sure that safety valves of big boilers are blowing and that the boiler attendant is blowing down and pumping up. All this may be taken as usual practice in the Sugar Industry and many other industries as well. Boiler blow down then is a much bigger thing than is generally supposed.

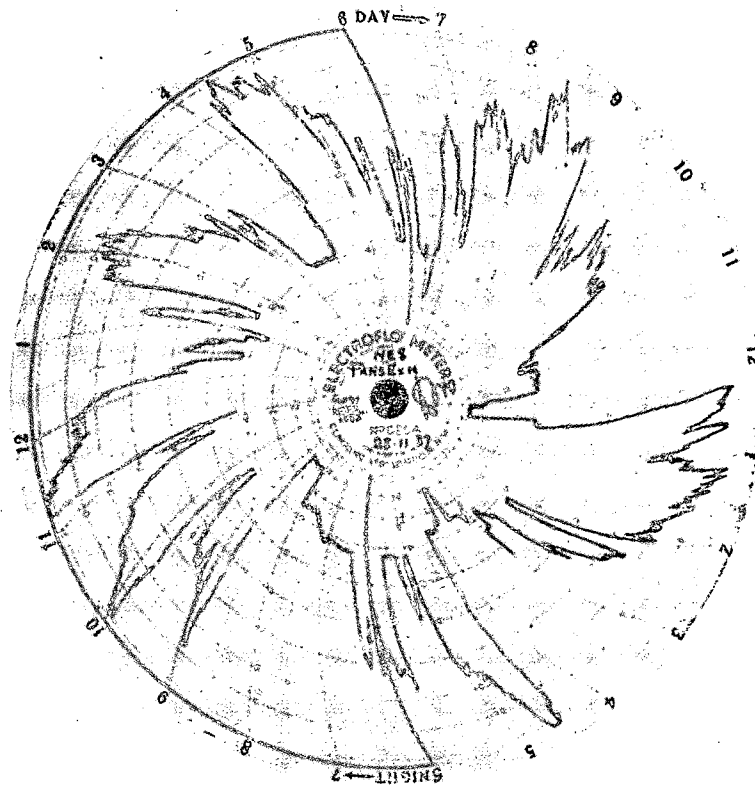


Fig. 1.

fluctuations in steam demand lead to similar fluctuations in boiler pressure and to comparatively frequent blowing of the safety valves. When these blow the boiler attendant naturally pumps fresh water into the boilers and blows down heavily which of course increases make-up.

To make the point clear a couple of flow meter charts are reproduced.

The first one Fig. 1 labelled N.E.8. PANS EXH shows the flow of exhaust steam to a pan station. You will see that from 11.20 to 11.50 a.m. the draw of steam is 8,000 lbs./hr. and then in less than $\frac{1}{4}$ of

Boiler blow down is necessary owing to impure feed make-up water. If there were no feed make-up or if the feed make-up were pure condensed water then blow down would be unnecessary.

The amount of blow-down should be proportioned on (1) The quantity of feed make-up and not on the quantity of feed (2) The amount of solids in the feed make-up water recorded as grains per gallon.

Grains per gallon are the engineer's ordinary units and are easier for him to calculate with and visualise than parts per million and should be ad-

hered to. The conversion however is simple as a gallon weighs 70,000 grains.

The true function of blow down is to keep down the concentration of soluble (sodium) salts which could cause priming and to get rid of the insoluble lime compounds which can cause scale and are blown out as muds.

These muds are best got rid of by more frequent blows of smaller amounts.

The easiest way to get a clear idea of how blow down works is to indulge in a little engineering arithmetic about it. Taking a typical sugar Mill B. & W. boiler of 4,780 sq. ft. H.S., with two drums 4 feet x 22.5 feet; holding about 4,200 gallons of

The boiler solids at first would run thus:—

Initial solids	= 24 gr.p.g.
Increased concentration	
68.6 x 6 gr.p.g.	= 412 gr.p.g.
Boiler solids at week-end ..	= 436 gr.p.g.

Here we should consider what maximum concentration to allow in a boiler. Ship's boilers have worked well at 160lbs. pressure on ocean voyages with sea water make-up. Sea water contains 2,500 gr.p.g. of solids so boiler concentration must have been high at the end of the trip. However nowadays we are told that 300 gr.p.g. is a high figure so we had better fix a limit of 200 gr.p.g. for our calculation:—

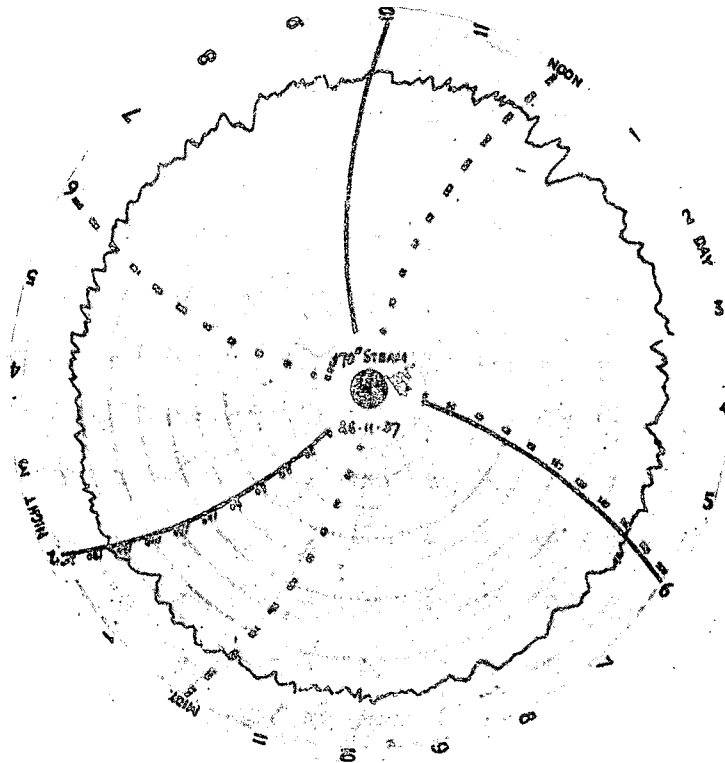


Fig. 2.

water altogether; and evaporating 4.1 lbs. sq. ft. hr., or 2,000 gallons per hour; then in 4,200/2,000 = 2.1 hours the original 4,200 gallons of water in the boiler have been evaporated and replaced. But the original water has left its solids behind so we can say that:—

Time of 1 concentration	= 2.1 hours
And in a week of 144 hours ..	= 144/2.1
Increase of concentration ..	= 68.6

If the boiler feed consisted of 75% returned condensate and 25% make-up water containing 24 grains per gallon of solids, naturally the feed water would contain 6 grains per gallon.

Limiting solids	= 200 gr.p.g.
Initial solids	= 24 gr.p.g.
Increase of solids	= 176 gr.p.g.
Increase of concentration	
176/6	= 29.3 Cn.C.
Time of 1 concentration	= 2.1 hrs.
Hours to limit concentration ..	= 61.6 hrs.

Now at the end of the week the boiler plant is shut down and to get rid of the steam pressure the boilers are blown down and pumped out.

Referring to Fig. 3 a Flow Meter Chart Marked H.P. BOILER FEED shows a week-end shut-down

and you will see that blow-down lasted from 6 p.m. to after 8 p.m. Thus from our factor of 2.1 hours per increased concentration it is clear that water equal to the entire content of the boiler has been blown down and the solids in the boiler will have been reduced from 200 gr.p.g. to 100 gr.p.g. and with this the new week will start. So we begin a new arithmetic sum to represent an average week.

Increased concentration	
Initial Solids	= 100 gr.p.g.
Limit	= 200 gr.p.g.
Increase allowed	= 100 gr.p.g.
Increased concentration	
100/6	= 16.7 Cn.C.
Time of 1 concentration	= 2.1 hrs.
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Time to limit concentration ..	= 35 hrs.

Amount of water to be blown down	
4.200 Gal. x 11.4% ..	= 480 Gals.
480/6.2	= 77.5 cu.ft.
Water surface 2 Boilers, drums	
(4 + 4) = 8ft. x 22.5	= 200 sq. ft.
Inches of gauge glass 77.5/200	= 0.388 ft.
to be blown down	= 4 5/8 ins.
per shift	= say 5 ins.
Blow down per hour 480/8 ..	= 60 G.p.hr.
Boiler Evaporation	= 2,000 G.p.hr.
Blow-down as % Feed	$\frac{60}{2,000} = 3\%$

Blow-down at this rate on a 100 tons cane per hour plant would cost about 15/- per shift or nearly £400 per crop but it is by no means certain that this figure is not very greatly exceeded in some

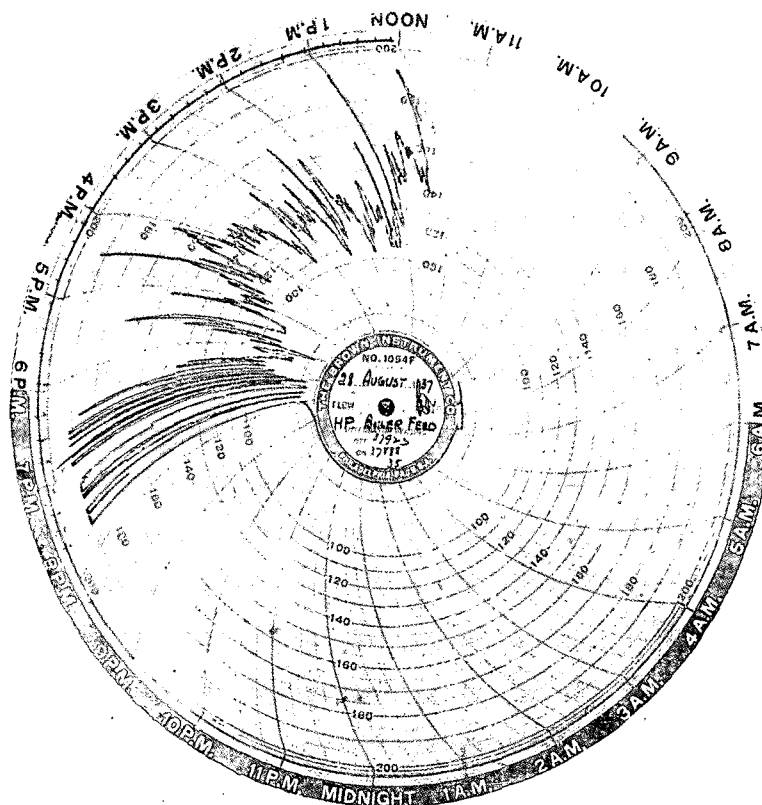


Fig. 3.

Thus blow-down is not needed during the first 35 hours of the week, after this how much should we blow down per shift.

Shift	= 8.0 Hours
Time of concentration	= 2.1 Hours
Added concentrations per shift	
8/2.1	= 3.8 Cn.C.
Boiler concentration 200/6 ..	= 33.3 Cn.C.
Fraction of boiler content to be	
blown down	$\frac{3.8}{33.3} = 11.4\%$

cases. Of course the cost of using 25% of cold feed make up would be many times the above sum.

Control of blow-down means taking regular and at first frequent samples of water from each boiler and of the feed water as pumped and of the make up water, the whole of these would form one batch. The chemical laboratory will measure the solids and report in grains per gallon and not in ohms, resistance of a sample nor in mere hardness. If the chemist can find an electrical test which saves him labour so much to the good but the chemist should

convert his test into grains per gallon and not dump the responsibility on the engineer.

The figures must be clearly logged in a book with a column for each boiler, and for feed etc. and with a record of any facts which may affect the make up. for instance source from which it is drawn and rain or drought. After a very short time a glance at this log would guide the engineer in his effort to keep costs down.

The solids in a boiler water resolve themselves into two classes—

(a) The lime salts which become generally insoluble at boiler temperature and so are liable to form scale and are blown out as mud. These muds are best got rid of by frequent blow-downs of a small quantity of water.

(b) The sodium salts which in general remain soluble at boiler temperature and which are liable to cause priming.

The water inside a boiler is at the temperature of saturated steam and when a sample is drawn off the temperature must instantly fall to 212°F. At 170 lbs. steam pressure the water temperature is 373°F. so there is a drop of 161°F. which results in about 17% of the weight of sample going off in steam and further in cooling from 212° to say 72° in the Laboratory there is a drop of 140°F. which means that another 11% of the reduced sample goes off in vapour.

This entails that the concentration measured in laboratory is 33% denser than what exists in the boiler. I do not believe that this correction has ever been made and we had better not apply it ourselves.

Two facts should be emphasised here. This paper deals with blow-down only and blow-down is the consequence of feed make-up which is generally a far greater loss than blow-down. Also the calculations refer to a particular boiler with a definite rate of evaporation and a definite impurity in the feed water. However they show a simple method of calculation for all boilers.

Some of our power station friends may feel very superior when they think of factory conditions but they should remember circumstances. Processes may demand the boiling of semi-corrosive fluids in thin walled vessels, any failure of which would foul the feed water. Minor mechanical trouble in one machine of a long continuous train may and frequently does shut down a whole plant working at full load. Above all, power supply is merely one of many essential services instead of being the one object of existence.

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The PRESIDENT: In complimenting the writer on the paper, pointed out that it was an example

where the chemist could help the engineer. The value of the paper was that it showed us how to conserve the steam in our factories, now that we had to handle new variety canes.

Mr. BECHARD: Congratulated Mr. Mackesy on an interesting paper, and again emphasised the importance of saving steam in view of the new varieties coming in. He said rather than limit the blow down, one should really blow down more frequently. Referring to the concentration of solids in boiler feed water, he said Amatikulu had adopted 200 grains per gallon but more in the nature of an ideal. The writer had taken a boiler steaming easily with a heating surface of 4,780 sq. feet and evaporating 2,000 pounds per hour, which was about the usual rate. A similar boiler at Amatikulu with a heating surface of 7,000 sq. feet, evaporating 35,000 pounds per hour, showed a somewhat higher evaporation, 5 lbs. Mr. Mackesy had pointed out that the total loss on a sample drawn from a boiler was about 35%, but he himself found it difficult to overcome the loss in cooling after sampling which would reduce the correction to somewhere about 20%. Lastly, he thought the charts very useful as they recorded the variation in the load in the demand for steam.

Dr. HEDLEY: Referred to his own connection with boiler work and reminded the audience of a semi-historical sketch written last year on the progress in boilers. In that paper a closed system of condensate had been suggested, collecting all the hot water from the various parts of the factory. In such a way one would be returning hot water which was also pure. Mr. Porteous had also pointed this out in his paper. The great advantage was that the solids entering the boilers would be reduced. He referred to the great amount of solids which do go into a boiler, especially during rainy weather when the water had not time to settle. He thought that make-up water ought to be purified, particularly at certain factories. In any case it would reduce corrosion, as the amount of oxygen would be reduced. In samples taken by him, and published in the Proceedings, he had obtained as much as 800 parts of solids. Dr. Hedley concluded by thanking the writer for his paper.

Mr. HAYES: Spoke on the subject of sampling boiler feed. Instead of the correction figure of 33% mentioned, modern opinion required that there should be no correction at all. No sample should be taken at the boiler at anything over the atmospheric temperature. In addition to this one should make sure that the sample is representative.

Dr. HEDLEY: Said he had taken samples with a gauge glass through a condenser. He used a copper condenser and the sample for analysis came out sufficiently cold not to evolve any vapour.

Mr. W. C. LINDEMANN: Referring to the subject of sampling, said he had experience with a

marine B & W type, also a double and triple land type. He found that in a marine type two different samples could be taken. Dr. Hedley was correct in taking the sample through a condenser under atmospheric conditions. In the Babcock marine type, the sample taken from the left hand side gave a lower reading than the right hand side. In the double land type the circulation of water was just the opposite to that in the marine type owing to the system being opposite, and here the values of the left hand of the double drum would correspond to the right hand in the marine type, and vice versa. Mr. Lindemann went on to say that he had found that when two liquids move at right angles to each other a magnetic field is set up. Phenomena such as this illustrated the necessity for research, and he would like to endorse Mr. John Murray's suggestion with regard to an Engineering Research Department at the Experiment Station. He thought it an excellent idea. The figures in Mr. Mackesy's paper might easily be upset if treated co-jointly from a mechanical and electrical point of view. He said that the Sugar Refinery had, under Mr. Wilson's supervision, converted a land type boiler in such a way that the distribution of solids whenever taken was very uniform indeed. He thought there was a possible solution to the unequal distribution of solids in the steam generator. He hoped other engineers would take this problem further, because mechanically it was sound.

Mr. G. C. WILSON: Congratulated the writer on an interesting paper, but said that no mention had been made of the heat loss in a boiler where the quantity of water necessary to keep the solids down had been given. The practice to-day was to put in heat exchangers and use the heat in the blow-down water to heat the make-up water, which goes back to the feed tank. This system together with the closed system, mentioned by Dr. Hedley, were being used to-day by a good number of the larger refineries and estates. The condensed water

never came into open contact with the air and went right back to the boiler. Regarding water purification the Refinery had a purification plant which gave good water for boiler make-up. Originally containing 15 grains per gallon it was reduced to about $3\frac{1}{2}$ grains in the feed water, and at the weekend the boilers were blown down and filled up on Sunday with river water containing 15 grains per gallon. On Monday morning that rose to between 60 and 70, notwithstanding that two inches were blown down from the boiler three times in each eight hours. Unless this blow-down was carried out, involving as it did a waste of heat in hot water, the solids would rise. He quoted an example where it had risen to between 250 and 300 and despite superheating, the steam had carried over a finely-divided deposit which deposited on the colder surface of the valve chest in the turbine and the blades of the first two stages of the turbine. This deposit once jammed the after reducing valve. In view of this the concentration was kept down below 200 grains per gallon.

Mr. MACKESY: Thanked the speakers, and replying to Mr. Bechard said that he had chosen 200 grains per gallon as an average figure, and that had now been supported by Mr. Wilson.

Referring to Mr. Lindemann's remarks he thought the electrical theory ought to be investigated. With regard to the taking of samples Mr. Mackesy thought that the use of a condenser was not practicable particularly where there were a number of boilers to be tested. He thought that working out the correction for evaporation was quite satisfactory. He concluded by referring to an instructive paper on electrical conductance measurements of water and steam read before the American Society of Mechanical Engineers in June 1930.

The PRESIDENT: Thanked Mr. Mackesy, and expressed his pleasure at the long and interesting discussion that had ensued.