Porta's Water Treatment

In SR 331. Phil Sowden of the Severn Valley Railway presented a very interesting article on how the SVR has been dealing with various boiler problems caused through boiling water. The SVR's 'external' remedy treats the water prior to it getting into the water tanks, coupled with a further addition of chemicals to the boiler of each locomotive to deal with the remaining problems.

Legendary engineer L D Porta was a pioneer of modern steam locomotive development. The story behind his revolutionary boiler water treatment is told by Shaun McMahon in Argentina and Martyn Bane in the UK.

This 'external' treatment, which relies on fixed lineside equipment at each water column, is one of two, acknowledged solutions. The other is 'internal' treatment. Such treatments use chemicals added directly to the water tanks in order to treat the water without off-loco treatment. One such treatment, professionally considered by the present authors to be the most advanced of its type, is Porta Treatment.

The History

Porta Treatment was developed by a research-and-development team from the Argentine State Technology Institute (INTI) led by the legendary Argentine steam engineer Livio Dante Porta. Between 1969 and 1974, working on the northern Argentine metre-gauge network, Porta's team built on the developments made in France before the Second World War.

The French regime TIA (Traitement Integral Armand) had revolutionised boiler conditions in France. (A number of boiler repair shops actually closed through lack of work!) Washouts, a major influence on locomotive availability, were reduced from weekly to just once every five months.

Porta took TIA, updated it and adapted it for the very low-tech environment he had to contend with. He advanced it in such a way as to forever alter the approach to internal water treatment.

Porta insisted on one simple statement: "What counts is what is in the boiler, not what is fed into it". In other words, water type (soft or hard in layman's terms) is of no consequence. All that is of concern is the water chemistry that exists inside the boiler by maintaining certain chemical concentrations in the boiler water.

These tubes show the classic problems of scaling (the grey/white deposits) and corrosion. MARTYN BANE.

Porta Treatment uses chemicals which, even in high concentrations have a very low risk factor. Making all aspects of the treatment safe was a very important criterion during Porta's development. While the treatment shows a relatively high pH number of at least pH11, the chemicals used to achieve this condition present very little risk to those applying them, testing the water conditions and washing out; high pH does not automatically mean danger!

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In Practice

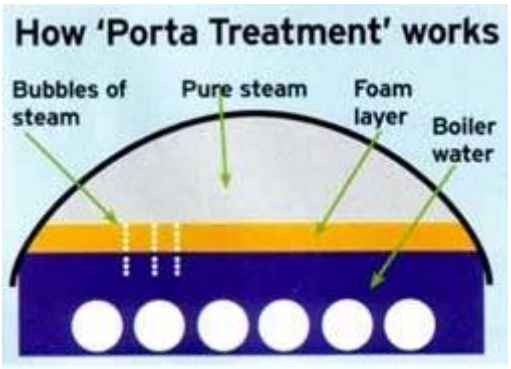
Following five years of development, Porta Treatment went into fleet use on the Argentine metre-gauge. It showed the following to be possible:

1. New scale formation was prevented and old scale was actively removed
2. Mud build-up was eradicated: all material was held in suspension instead.
3. Corrosion was stopped dead.
4. No caustic embrittlement occurred (a phenomenon caused by high stress and certain chemicals).
5. Pure steam was produced.

The final item may seem strange. Is not all steam pure? The answer is no. A steam power station engineer will confirm that turbines are destroyed by impure steam. Contamination is caused by dissolved or suspended solids in boiler water carried in the steam flow.

In locomotives, this contamination which is generally invisible, has been shown to reduce component life by 10 - 15%. Which components? Superheater elements, throttle (regulator) valves, valve and piston rings, glands, air pumps, vacuum ejectors etc. Mixed with lubricating oil, steam contaminants act like grinding paste. Scientifically conducted steam-purify tests on locomotives have shown it is not unusual for 4lb of contamination to be found in 4000 gallons of condensed steam.

Such high levels of contamination can be present when running with fairly low levels of solids in the boiler water, lower than the norm in many locomotives. The prevention of this contamination should be scientifically approached priority. Porta's holistic theoretical and practical techniques did not perceive steam locomotives as purely mechanical machines, but as interlinked heat engines.



Porta was able to ensure steam purity by using specific antifoams in his treatment. These create a layer of foam on top of the boiler water not unlike the head on a pint of Guinness. This dense foam acts like a sieve to the steam and ensures its purity.

Monitoring

Monitoring of boiler water conditions has, traditionally, often involved the use of harmful chemicals. With Porta Treatment only the pH and level of dissolved solids are monitored. Both are very easy and safe to measure. There is no need to measure factors such as caustic alkalinity or tannin levels. The monitoring and control is so simple that no chemist, or consultants ever need be involved on site once a regime is operational.

On the Argentine metre-gauge system, the treatment reduced washouts to just two per year, despite exceptionally 'hard' water in a region of semi-desert. Before the treatment, washouts were weekly and even then heavy water carryover occurred after just a couple of days. Heavy boiler repairs which had occurred once every two years were virtually eradicated. Impressive results by any standards.

Development

It was Porta's habit to improve on what he had already achieved and so he never gave up advancing his own well thought-out systems. Porta Treatment was further refined and simplified during the last years of his life when working in Cuba.

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In parallel, work was undertaken on the Ferrocarril Austral Fueguino (FCAF) at the very tip of South America. Here it was shown that 12 months between washouts and internal inspection was possible, safe and acceptable to national boiler inspectors. It also illustrated that the experience further north was no freak. In the very different FCAF conditions, if anything, the treatment had performed even better.

[Note: Prior to the introduction of 'Porta Treatment' various external treatment regimes that had been used but found to be ineffective. These systems were removed and scrapped once 'Porta Treatment' was introduced.]

Testimony

Porta Treatment has been used or is currently in use in South Africa, Brazil, Australia, the former USSR and the UK. Where it has been used, the results are as expected: boiler maintenance being reduced to routine tasks only such as washouts. If allowed by local regulation, tube life in excess of 20 years has been shown to be a reality with repairs being dictated by fireside erosion and external corrosion.

The 15in-gauge Kirklees Light Railway is one of Britain's key players in locomotive development, including investing the 'Porta Treatment'. On Kitson-Meyer 0-4-4-0T Hawk enters Clayton West station. CURTIS WELSH

In the UK, the 15in-gauge Kirklees Light Railway, under the direction of Engineering and Operating Manager, Ian Screeton, introduced the treatment in 2005 following severe corrosion problems in its boilers. Since then, boiler repairs have been eradicated. Interestingly, one comment made by Ian is that immediately after the treatment's introduction, oil on valve stems and piston rods changed colour, showing that pure steam was being produced.

Following this positive experience, and thanks to the foresight of the locomotive's engineer Steve Underhill, the *6024 Preservation Society Ltd* started to use 'Porta Treatment' on No 6024 "King Edward I" in April 2006. The previous lack of sustained treatment meant a lot of corrective work was required. As this article was being written, the second washout was almost due. The first removed a huge amount of scale from the boiler. More is expected. It is considered it will take at least two years to fully de-scale the boiler - not that it was especially heavily scaled in any case. However the benefits are already evident.

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No 6024 is the first locomotive running on the treatment to be fitted with a copper firebox as far as the authors are aware. However this does not mean it is the leap into the dark that this statement may seem to imply.

Porta explicitly stated how to alter the chemical ratios (but not the actual chemicals) to suit. Any non-ferrous metal is susceptible to chemical erosion from high pH solutions. The key to this not being a problem with 'Porta Treatment' is that the treatment promotes the formation of protective layers on the water surfaces. These layers, which are microscopically thin, protect the underlying metal from chemical erosion. Thus it is possible to use bronze or gun-metal fittings without problems (as was done in Argentina).

Additionally, the French TIA and related treatments have a long and successful history with copper fireboxes. While 'Porta Treatment' pushes beyond these treatments, the actual water chemistry is not so far removed from them. If anything, non-ferrous metals are at less risk of erosion due to recent advances in the chemistry associated with Porta Treatment.

In Conclusion

Porta Treatment sounds like something of a Holy Grail. It Is certainly as close to a perfect water treatment as it is currently obtainable. However, the fact that it is not perfect in every aspect means that development has never really ceased.

Improvements and alterations were never far from Porta's active mind. Following his death, these ideas have been taken up and are currently under development. Nothing is ever the end point - to believe so is to accept ‘good enough' mentality when the reality is 'only the best will do'.

More details can be found at www.portatreatment.com.

Porta and His Supporters

Livio Dante Porter, born in 1922, spent his adult life developing the steam locomotive. He passionately believed it had much untapped potential and a very real role to play in world transport. He wrote more than 200 technical papers. Well-known technologies developed by Porta include the Lempor exhaust ejector and the Gas Producer Combustion System. However, equally important are less well-known technologies such as the lightweight, multi-ring, articulated piston valve and his radically different approach to compounding. He died on June 10 2003.

Shaun McMahon, whose railway career started at the Ffestiniog Railway in the 1980s, has long been an advocate of advanced steam. Working first in the UK, then South Africa and now Argentina, he has applied Porta's philosophy and technologies wherever possible. Working directly with Porta on various projects, he has ten years' first-hand experience of using 'Porta Treatment'.

Martyn Bane's lifelong interest in steam took a different direction in the late 1990s when he read of David Wardale's Porta-inspired work in South Africa and elsewhere. It was at this time he first became aware of 'Porter Treatment'. A series of chance meetings introduced him to several engineers involved with modern steam and opened a channel of communication with Argentina. He has been working with Shaun McMahon since 2002 on water treatment and other modern steam issues.

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