C O M M E N T S

on the article

"Die Speisewasser - Innenaufbereitung bei den Dampflokomotiven der Deutschen Bundesbahn".

written by

J. ROBRADE in Eisenbahnteschnische Rundschau, Mai 1956, 183-190.

Summary of the Comments:

The article confirms this discusser's thesis included in the water treatment developed for the Belgrano Ry. (Argentina).

An interesting contribution to the art (which this discusser incorporates into his creed) is injecting the cooling water for washouts in the superheater header (where the throttle is on the header) so that any deposits or oxides are flushed into the boiler, where they are harmless.

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L. D. PORTA

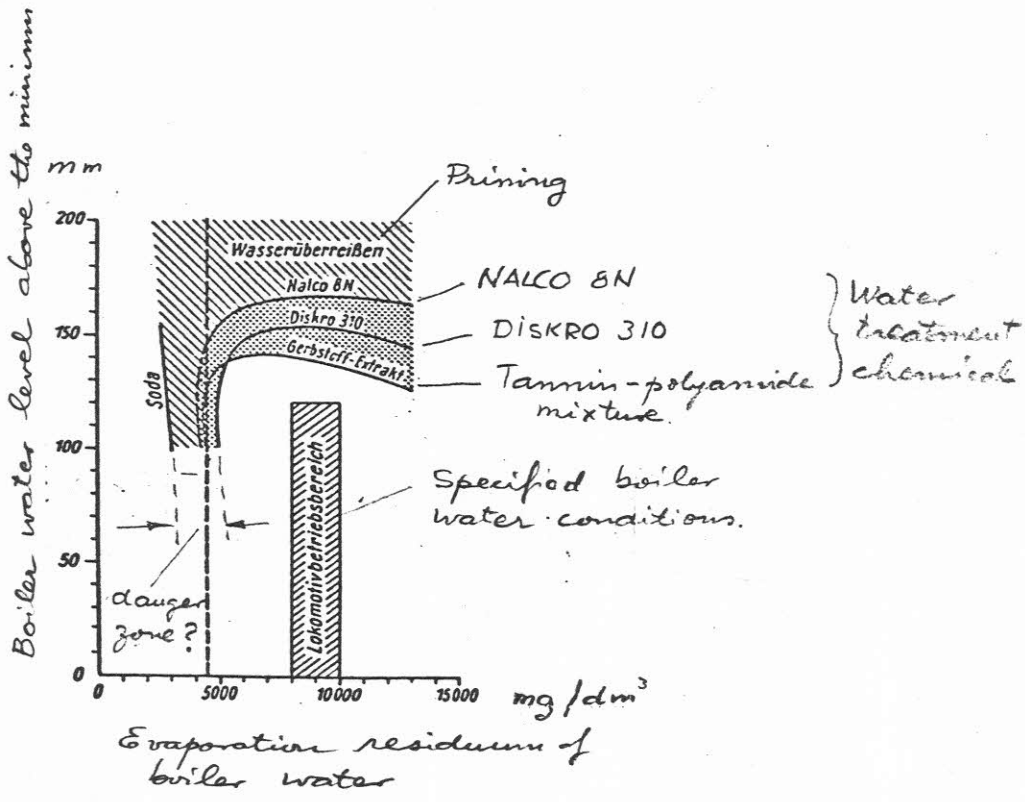

Fig. 1 Limits of boiler working conditions in relationship to priming.

C O M M E N T S, by L. D. Porta on...

ROBRADE, J.: "Die Speisewasser-Innenaufbereitung bei Dampflokomotiven der Duetschen Bundesbahn." Eisenbahntechnische Rundschau, Mai 1956, 183-191.

Besides confirming all that is known about internal water treatment (*), some additional information and new concepts are gained. The author points out that the now (1955) adopted internal water treatments are not just the classical because (i) means are included to make the sludge very fluid, non-settling, and (ii) antifoams are used permitting more latitude in boiler water chemistry. NO MENTION IS MADE ABOUT CAUSTIC ENBRITTLEMENT, which is somewhat surprising. This confirms this discusser's thesis (*) about not fearing for high boiler water alkalinities.

The author says that antifoams (poliamides are mentioned) allow for a complete softening of the water in the boiler. So far, this is the first time that this discusser has found such concept in the literature. The usual approach is that antifoams are used just to control foaming tendencies and not as a means of permitting a better water chemistry. This is an intermediate step in the way to this discusser's thesis, namely: ANTIFOAMS PERMIT TO PLAY AT WILL WITH BOILER WATER CHEMISTRY AND TO CONSIDER THE BOILER AS A CRYSTALLIZER.

The following interpretation is offered for the information coming out of Fig. 1. First, it is apparent that a minimum TDS (total dissolved solids) is required for the antifoams to work. This checks with information coming from East Germany, and confirms this discusser's feelings based on his locomotive driving experience according to which "things are proper when you get above a certain minimum water concentration".(+) In East Germany, the recommendation is to get above 6000 ppm as soon as possible after a washout (no blowdown!) when

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(*) PORTA, L. D.: "Steam Locomotive Boiler Water Treatment" (unpublished).

(+) apparently 4500 ppm from Fig. 1.

the boiler is filled up with unconcentrated water. The steepness of the curves near the minimum ($\approx$4500 ppm) suggests that the concerned phenomena are very definite, for it repeats for all the three different antifoams. This discusser never tried an experimental check on said "feelings."

Again, this goes against the old religion of blowdowns (purges).

The curves are limited to a minimum level showing in the glass of 100 mm (4 in). This implies that working below that figure is "officially" not normal.

With all probability, the curves refer to the normal "rated" evaporation.(*) Since three different and very close lines are given, the implication is that their accuracy is on the high side, a difficult matter to achieve if tests are carried out on the road: the German standard "tube" glasses show considerable oscillations. This leads to thinking that the tests have probably been carried out under stationary conditions. The implication is also that an accurate definition is applied to differentiate "water entrainment" (wasseruberreissen) from "non-entrainment". The article mentions (p.191) that steam purity has been many times monitored. It has been established that good antifoams lead to a sharp definition of the top foam surface (PORTA, l.c.), this in contrast with less powerful antifoams (or no antifoams) which lead to filling the steam space with large bubbles. These large bubbles are associated with a definite steam wetness and contamination which decreases with the height above the water level. Yet, this wetness is not enough to cause a noticeable steam temperature drop or to appear as visibly humid steam in the exhaust. Accepting that an interpretation of the German word "wasseruberreussen" means "significant steam contamination", the implication is that with the antifoams referred to by the author (and its mode of use) the foam height above the water level showing in the glass is considerable. Taking the height of the steam space of German boilers as about 400 mm (16 in), that foam height should have a thickness of $\approx$250 mm (10 in) because said significant contamination appears when the water height in the glass is above 150 mm (6 in). This is contrary to this discusser's

(*) 57 kg im^{-2} h^{-1}; 70 kg im^{-2} h^{-1} for post war designs.

experience in which the foam height, assessed both by control electrodes and steam purity measurements, has consistently been less than 70 mm (3 in.). This interpretation of foaming phenomena as shown in Fig. 1, as it is recognized, leaves much to be desired (*).

It is interesting to note that above a given concentration ($\approx$6000 to 8000 ppm) the TDS has no (or decreasing) influence on foaming. This checks well with this discusser's experience (related to diestearildietilendiamide!) in which TDS up to 58000 ppm have been tested at steam space loadings probably threefold of those of the German figures.

The specified TDS is between 8000 and 10000 ppm. The concept is thus one of a range and not one of maxima as was the current one. In the treatment developed under the direction of this discusser at INTI, the concept of a minimum TDS ($\approx$10000 ppm) was also established, the maximum set at about 20000 ppm. The small range provided in Germany requires considerably more control.

The author's note about the baking of precipitates which results from emptying a hot boiler immediately after releasing the steam pressure is known, and, for example, French instructions prescribe that the washing out procedure should begin immediately after the firebox crown has been cleared out of water. In Germany, a cooling down procedure is practiced. In engines having the throttle after the superheater, a connection is arranged in the superheater header so that the cooling water is used to flush the elements out of deposits. The latter consist of $Na_2\ CO_3$, Na O H, $Na_2\ SO_4$ and solid sludge (mostly Ca CO_3), i.e. largely water soluble stuff. This discusser incorporates this arrangement to his creed because of its simplicity and convenience. Besides, the chances are for any oxidized or gritty matter to be entrained to the boiler where it is harmless. NOTHING IS ENOUGH TO GET THE MAXIMUM STEAM PURITY BEARING IN MIND ITS EFFECT ON CYLINDER WEAR (+).

(*) It is noted that, because of the wagon top characteristic of German boilers, the 250 mm figure becomes some 150 mm if it were referred to an ideal boiler whose evaporation surface is independent of the height: the BELPAIRE firebox used in this discusser's tests approaches this condition.

(+) See Appendix to this discussion.

One of the rôles of the added organics is to scavenge oxygen, thus agreeing with INTI treatment in which quebracho tannin is added for that purpose.

In West Germany, the treatment is used to descale boilers, which extends over a period of six months (as in France). This discusser thinks that that time is excessive. It may be that an engine to be descaled can be put in light service for one week so as to reduce the risk of overheating due to heavy scale-shell accummulations.

As reported in the article, at last the Germans discovered that some "draining" holes (for example in the dry pipe and the auxiliary feed pipe) served the sole purpose of sending water containing dissolved and suspended solids into the superheater, air brake pumps, carriage heating systems, etc.!

This discusser learned that the hard way. Over 20 years, deposits in superheater elements and vacuum brake ejector cones puzzled him until these holes were discovered and plugged off.

APPENDIX

THE EFFECT OF SOLIDS IN CYLINDER WEAR

The analysis of carbonaceous deposits found in steam locomotive cylinders shows that they are largely made up of solid matters aspirated from the blast pipe during drifting, and solid material coming from the boiler. Both act as abrasives increasing the roughness of ring and liner surfaces, thus spoiling their ability to achieve hydrodyanmic lubrication when conditions lead to a very small film thickness. Thus, a premature metal-to-metal contact occurs, leading to increased wear. This wear is superimposed to abrasive wear. One of the reasons for oil filtering in internal combustion engines is the elimination of abrasive matter in the oil, even if the above mentioned mechanism has not been properly understood.

Die Speisewasser-Innenaufbereitung bei den Dampflokomotiven der Deutschen Bundesbahn

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Die Aufbereitung des Lokomotivspeisewassers hat für die Unterhaltung, Leistung und Lebensdauer der Kessel größte Bedeutung; sie wird heute in zunehmendem Maße als sogenannte Innenaufbereitung auf der Lokomotive selbst vorgenommen. Der an Einführung, Entwicklung und Überwachung des neuen Verfahrens bei der Deutschen Bundesbahn maßgeblich beteiligte Verfasser beschreibt dessen Wesen und Erfolge.

Treatment of locomotive feed water is of great importance for the maintenance, performance and life of the boilers. It is in an ever increasing degree performed as "interior treatment" on the locomotive. The author, one of the officials responsible for the introduction, development and control of the new system at the German Federal Railways, describes its features and the success achieved.

Le traitement des eaux d'alimentation des locomotives à vapeur offre un très grand intérêt du point de vue de l'entretien, du rendement et de la durée de vie des chaudières. De plus en plus le traitement de l'eau s'effectue dans la chaudière elle-même. L'auteur, qui a contribué pour une large part à de l'évolution des méthodes d'exploitation et de construction. L'auteur expose les résultats d'une étude portant spécialement sur le domaine de la voie.

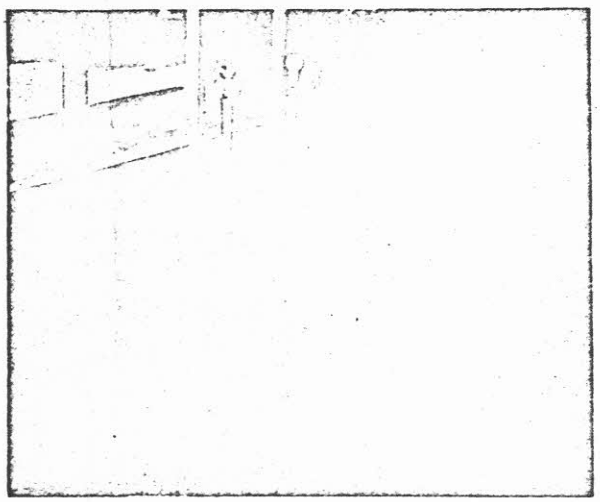
La preparación del agua de alimentación de las locomotoras, que es de suma importancia para el entretenimiento, rendimiento y longevidad de la caldera, se practica hoy en día en una medida cada vez mayor en la locomotora misma. El autor del artículo, que ha colaborado decisivamente en la introducción, el desarrollo y la vigilancia de este nuevo sistema en los FF.CC. Federales Alemanes, describe su naturaleza y los éxitos logrados a base del mismo.

A. Umfang der Innenaufbereitung

Die chemische Aufbereitung des Speisewassers im Lokomotivkessel selbst, die sogenannte Innenaufbereitung, hat in den letzten Jahren bei der Deutschen Bundesbahn einen großen Umfang angenommen. Es liefen mit Innenaufbereitung am 1. Mai 1952 178, am 1. August 1953 1906, am 1. August 1954 3650 und am 1. Dezember 1955 4585 Lokomotiven.

Wie ist diese rasche Ausdehnung zu erklären? Einmal durch den Umstand, daß nur geringe Aufwendungen gemacht werden müssen, um die Innenaufbereitung aufzunehmen. Zwei Vorratsbehälter, zwei Meßbecher zur Beigabe der Pulver in den Tender beim Wassernehmen, das sind die erforderlichen Geräte auf der Lokomotive. Im Bahnbetriebswerk werden ein trockener Lagerraum für die Chemikalien und ein kleiner Raum als Labor (Bild 1)

Bild 1: Wasserlabor im Bahnbetriebswerk mit Drehtisch.



zur laufenden Untersuchung der Kessel- und Tenderwässer benötigt. Das alles sind Aufwendungen, die ein Bahnbetriebswerk aus eigener Kraft aufbringen kann. Auf der anderen Seite stehen als beachtliche Erfolge saubere, steinfreie Kessel, mindestens auf das Doppelte verlängerte Auswaschfristen und Ersparnisse an Kesselarbeiten im Bahnbetriebswerk und im Ausbesserungswerk.

B. Die chemischen Voraussetzungen

Die Speisewasser-Innenaufbereitung hat zwei Seiten, eine chemische und eine verfahrenstechnische. Die chemische Seite ist im Laufe der letzten zwei Jahrzehnte von den Firmen Nalco (1) in Chikago, Lambro (2) in Mailand, Tannin Developments Ltd. (3) in England und von der SNCF (4) in Frankreich gelöst*). Allen Verfahren ist gemeinsam, daß die Härtebildner des Wassers in erster Linie durch Soda und Natriumbikarbonat ausgefällt werden. Die Menge dieser Chemikalien je Kubikmeter Wasser ist der Nicht-Karbonat-Härte proportional. Bei der Enthärtung werden die Härtebildner in wasserunlöslichen Schlamm, wasserlösliche Salze, Kohlensäure und Wasser umgewandelt. Das Neue an der jetzt angewandten Innenaufbereitung ist, daß die außer der Soda und dem Natriumbikarbonat dem Tenderwasser beigegebenen Spezialmittel, nämlich das Nalco 8N, das Diskro 310, das Gerbstoff-Polyamid-Gemisch sowie das TIA-Komplexmittel Stoffe enthalten, die den Schlamm und die Salze für den Kesselbetrieb erträglich machen. Die organischen Stoffe in den Spezialmitteln bewirken, daß der Schlamm nicht zähe und schwer wie Lehm zu Boden sinkt, sondern daß er eine flockige, leicht fließfähige Struktur annimmt. Auch nach stundenlangem Stehen im Becherglas folgt er sofort der Schrägstellung des Glases

*) Die Verfahren werden in der Bundesrepublik vertreten durch die Firmen
(1) Lurgi, Gesellschaft für Chemotechnik, Frankfurt a. M.
(2) Marquart AG, Beuel/Rh.
(3) Rheinische Gerbstoff-Extrakt-Fabrik, Karlsruhe.
(4) Krauß-Maffei AG, München-Allach.