FIRING PRACTISES IN MODERN RECOVERY BOILERS

Esa Vakkilainen, LUT University, Lappeenranta

Firing practices in modern recovery boilers

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This work updates liquor firing practices in Finnish recovery boilers from the previous 2004 data with new 2018 data. It was prepared under FRBC Liquor firing subcommittee by sending all boilers a questionnaire that was filled. Results from 2018 are compared to results to 2004.

The average liquor firing in a Finnish recovery boiler increased 330 tsd/d and the average boiler burned 2800 tds/d. Because several small boilers have been shut and the installed new boilers are big the average size increased significantly. The liquor to be burned changed slightly. The black liquor dry solids increased 1 % and the heating value decreased 0.3 MJ/kgds. Liquor firing per unit area of boiler bottom has clearly increased. Average value increased 17.4 → 19.4 tds/d m^2 and the HHRR 2820 → 3100 kW/m^2. Increase in firing capacity can be explained by new big boilers and progress in black liquor combustion, enabling more liquor to be burnt per unit area. All boilers except two use primary-air of less than 30 %. Most recovery boilers are using high over 30 % tertiary and quaternary air.

Liquor firing temperature corresponds to BPR. Also pressures have been kept at the same level. This is significant because the liquor firing per gun has increased a lot.

NOx emissions show a wide spread; 50–230 mg/Nm^3. Highest values have not decreased, but two boilers have a very low value. No boiler reported TRS that is higher than detection limit. Only few boilers gave dust emission close to 100 mg/Nm^3. The dust emissions have gone down significantly.

The main reasons for increased firing capacity are new, bigger boilers and development of black liquor firing. Now we can fire more liquor per same bottom area than before. Because the black liquor dry solids increased only moderately the main explanations are probably the improved control systems, new air systems and general improvements in liquor firing.

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2004 vs 2018

- In 2004 Finnish Recovery Boiler Committee conducted a study of Finnish recovery boiler characteristics and their operation
- This study is now updated by the data from 2018

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CHANGES IN RECOVERY BOILERS

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Changes in # of boilers

Laminating Papers	1957
Kymi SK1	1963
Sunila SK10	1965
Kemijärvi	1968
Kymi SK2	1976
Kemi, Stora Enso	1977
Kaskinen	1977
Varkaus	1980
Äänekoski	1985
Kaukopää SK5	1987
Sunila SK11	1988
Oulu	1988
Kemi, Botnia	1990
Kaukas	1991
Enocell	1992
Kaukopää SK6	1992
Rauma	1996
Joutseno	1998
Wisaforest	2004

19 kpl

Kymi SK3 2008

Kemijärvi closed

Kaskinen closed

Äänekoski 2017

Kotkamills	1959
Sunila SK10	1965
Sunila SK11	1988
Kemi, Stora Enso	1980
Imatra SK5	1987
Varkaus	1988
KemiB	1990
Kaukas	1991
Oulu	1991
Imatra SK6	1992
Enocell	1992
Rauma	1996
Joutseno	1998
Wisa	2004
Kymi	2008
Äänekoski	2017

16 kpl

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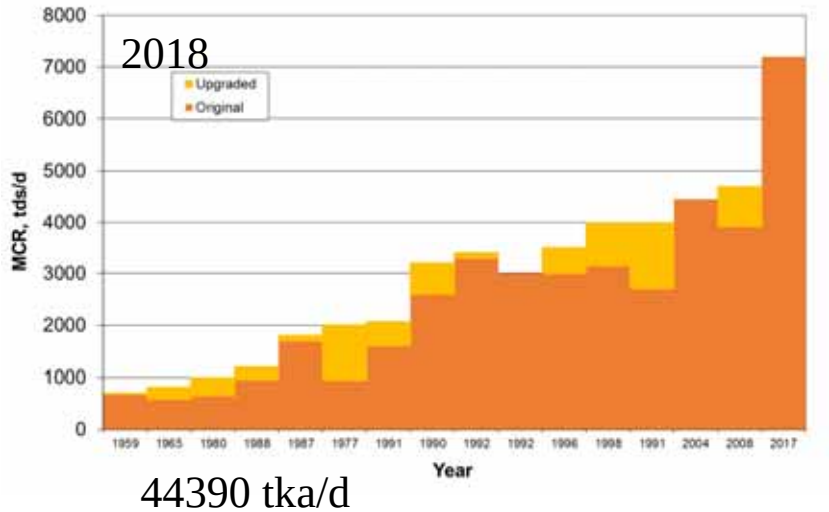
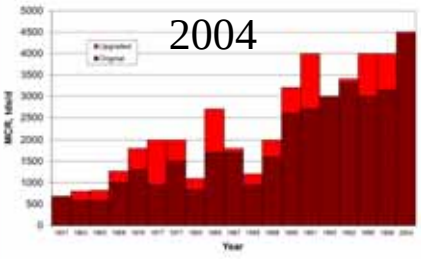
Capacity 2004 to 2018 +16%



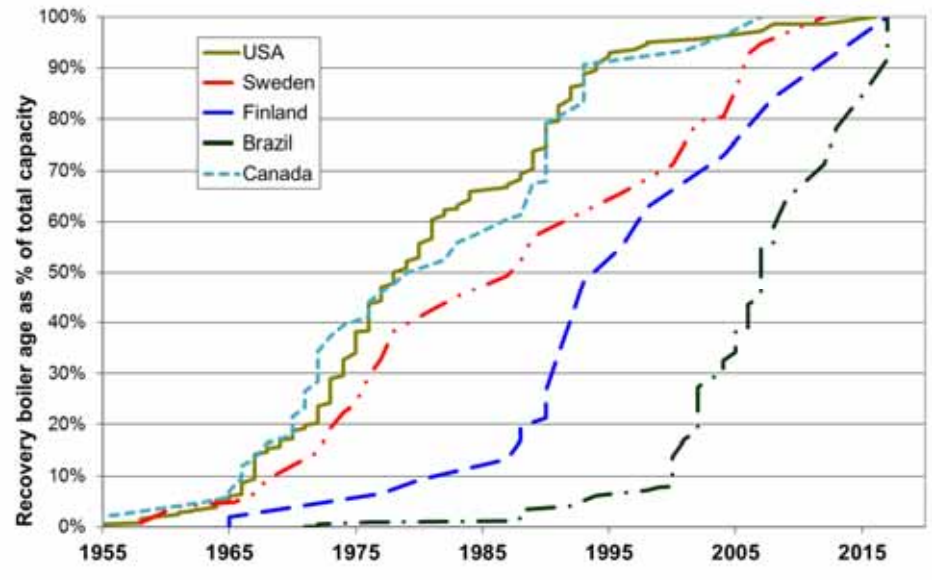
44390 tka/d



37670 tka/d

Now three recovery boilers that can do +5000 tds/d

Age of boilers ~30 years



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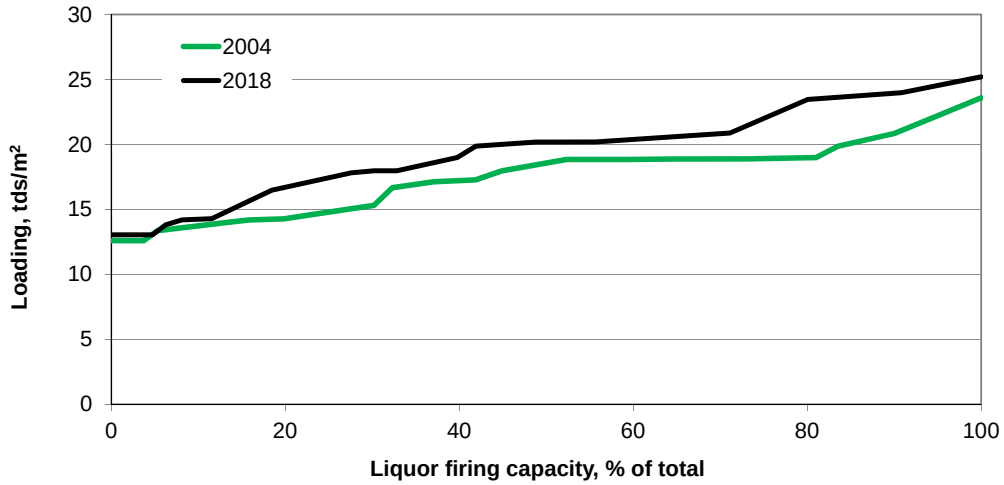
LIQUOR FIRING

More liquor fired



Half of the liquor fired at or over 20 tds/m^2

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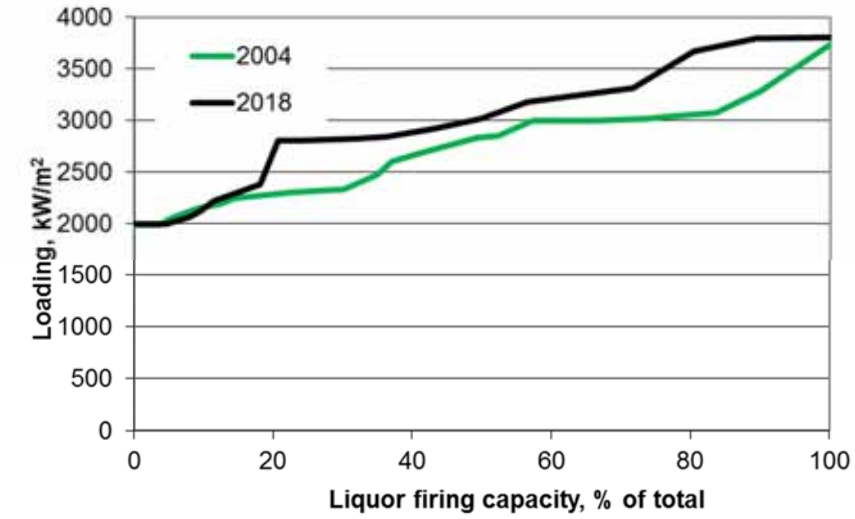
Bottom loading has increased



More heat released from black liquor per bottom area

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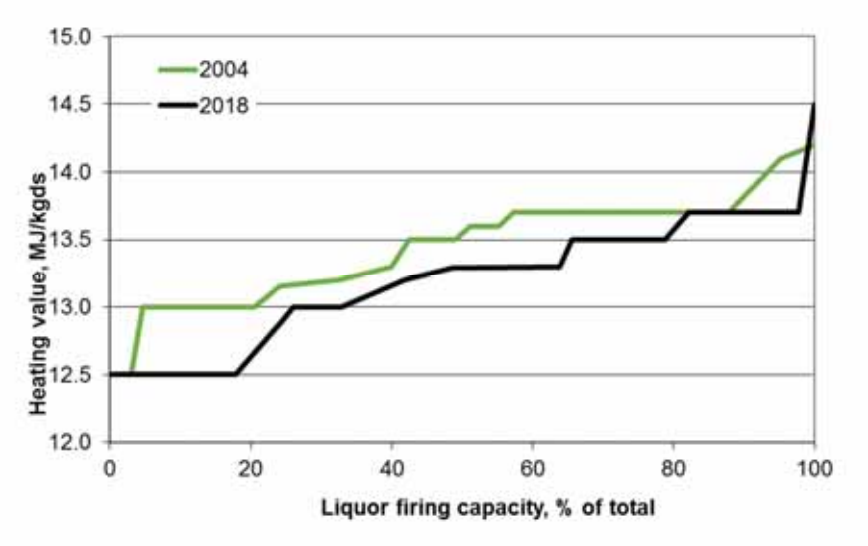
Liquor HHV decreased



Heating value decreased about 0.3 MJ/kgds or 2%

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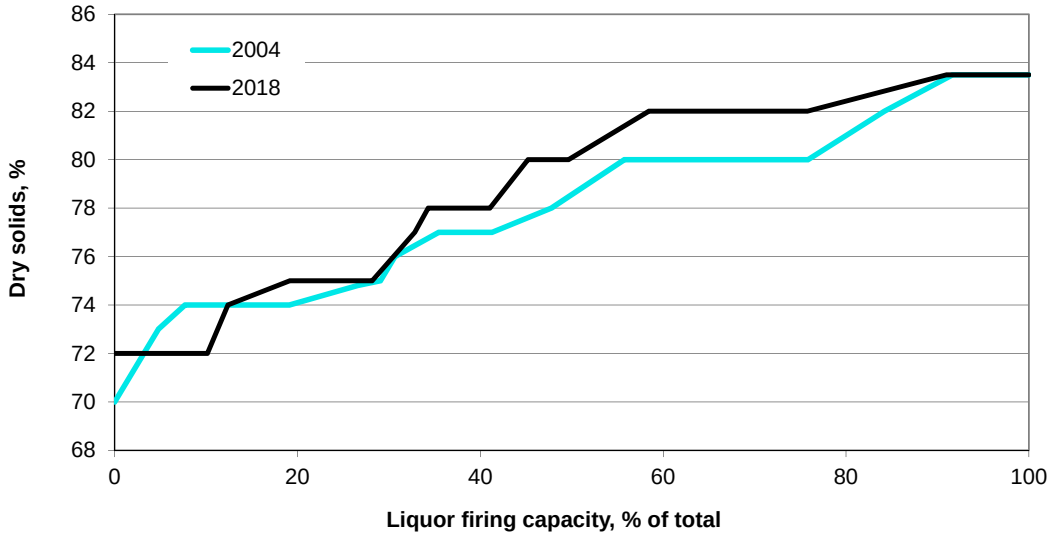
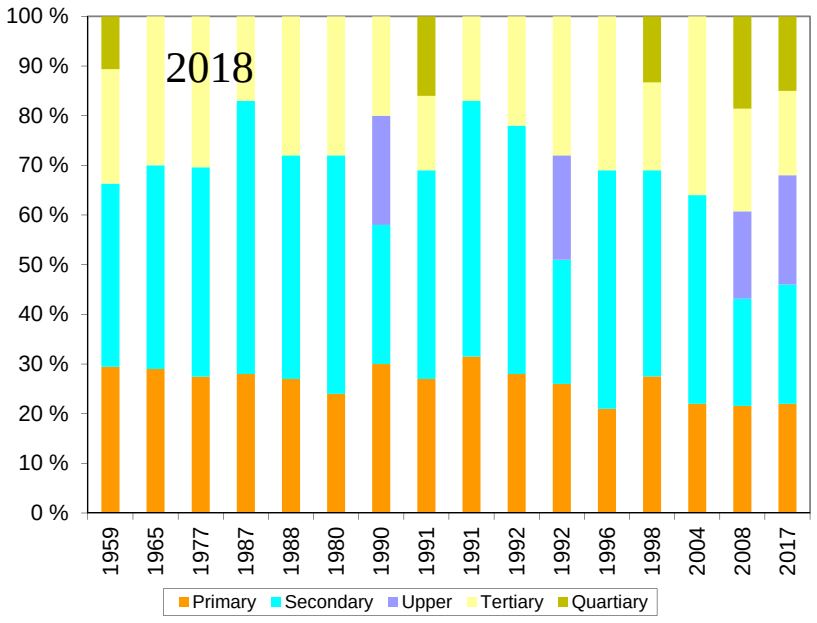
Liquor ds has increased

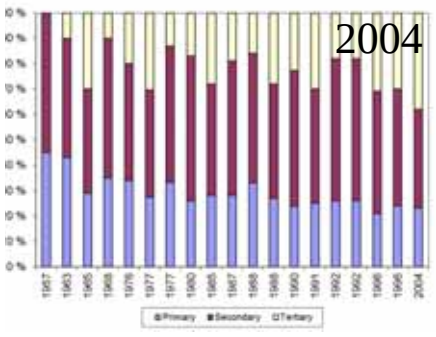


Dry solids increased about 1%

AIR SYSTEMS & SPRAYING

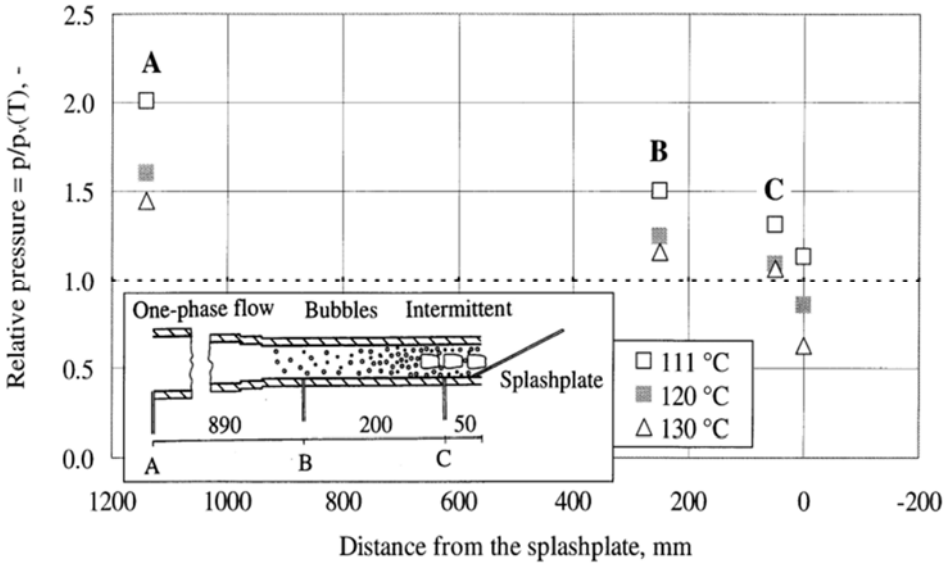
More tertiary+ – less primary





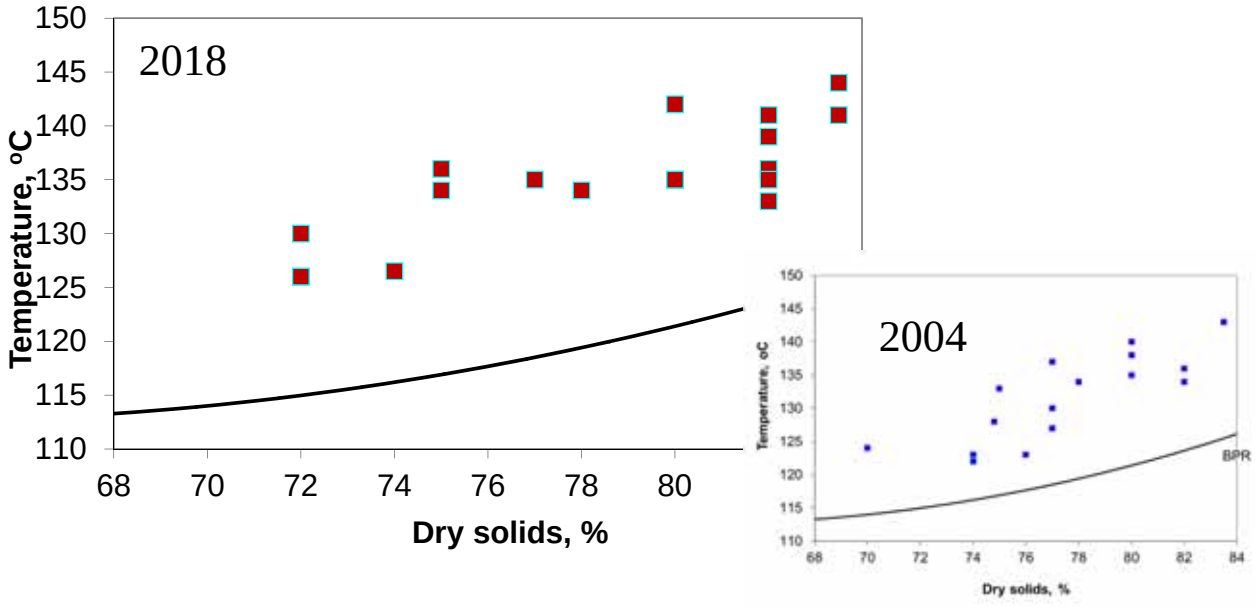
Primary <30%
Tertiary+ >30%

Note – modern spraying

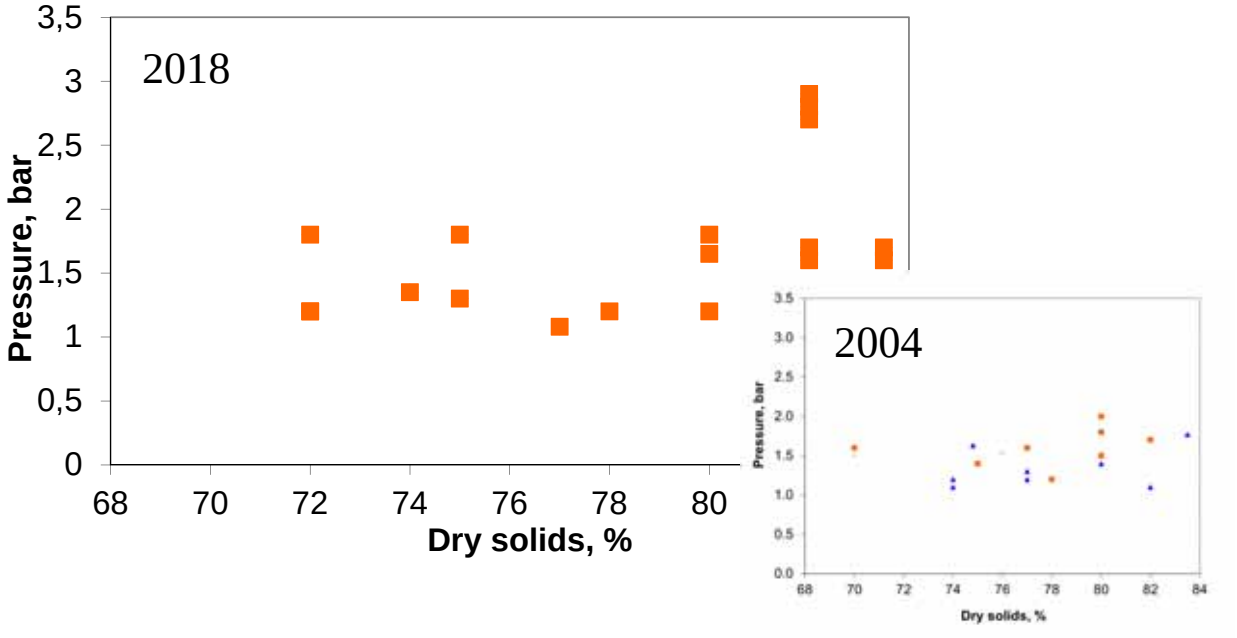


Kankkunen et al., 1998

Liquor temperatures similar



Liquor pressures similar



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EMISSIONS TO AIR

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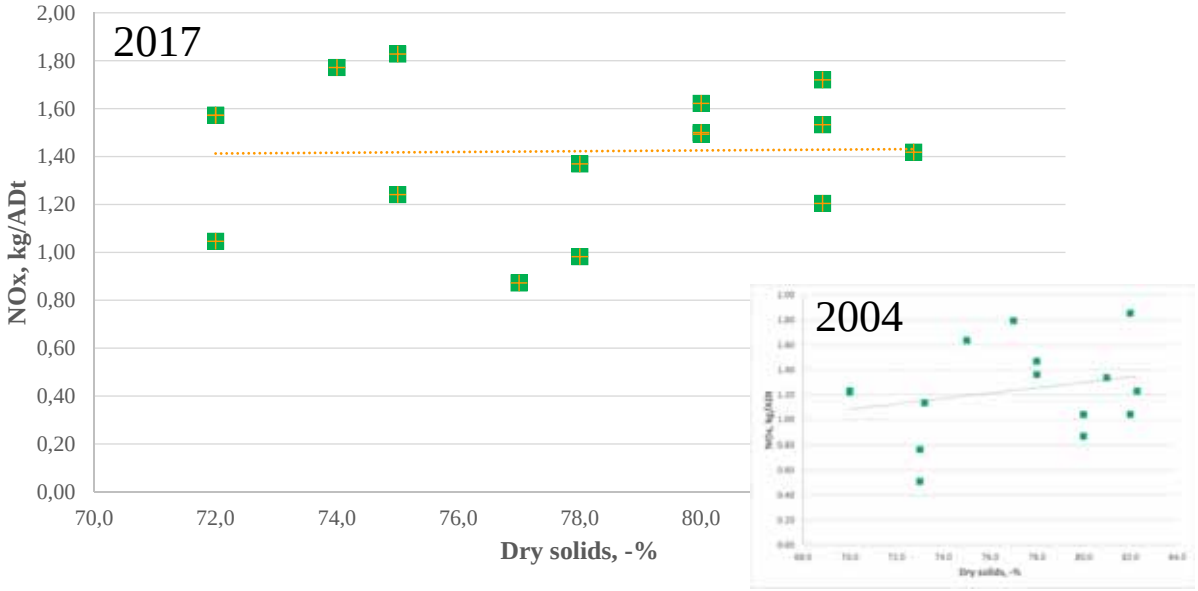
Mill NOx



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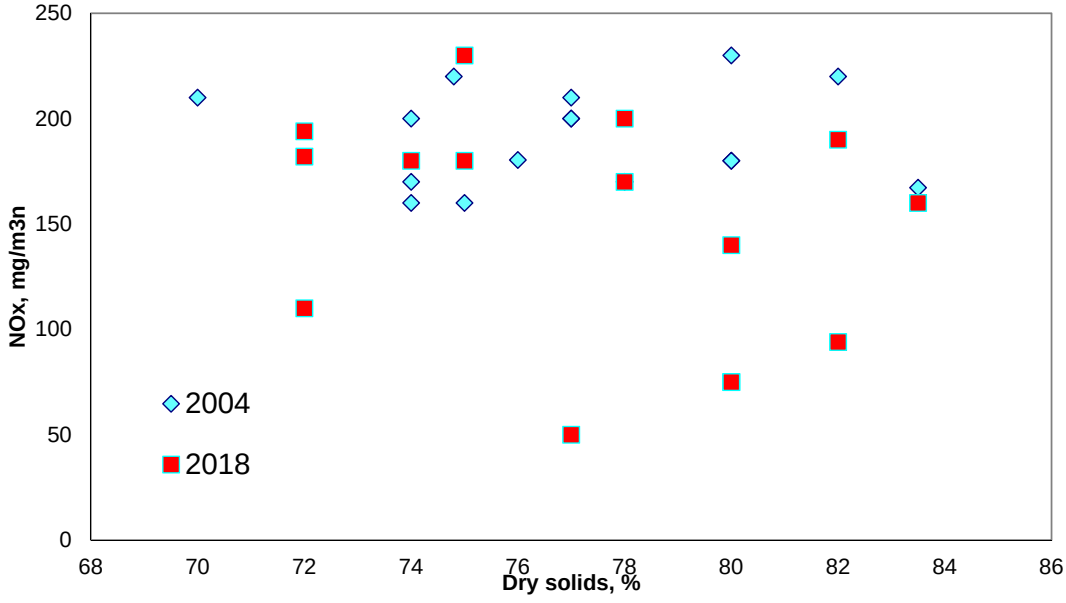
Recovery boiler NOx



Some boilers report lower NOx than before

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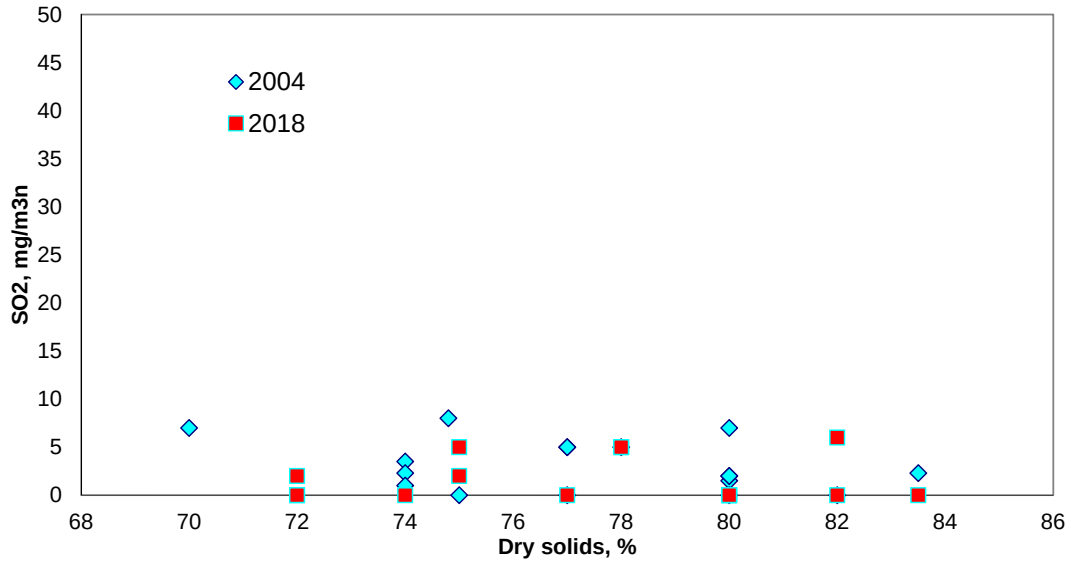
Recovery boiler SO_2



All boilers report low sulfur emissions (2004 one boiler ~100)

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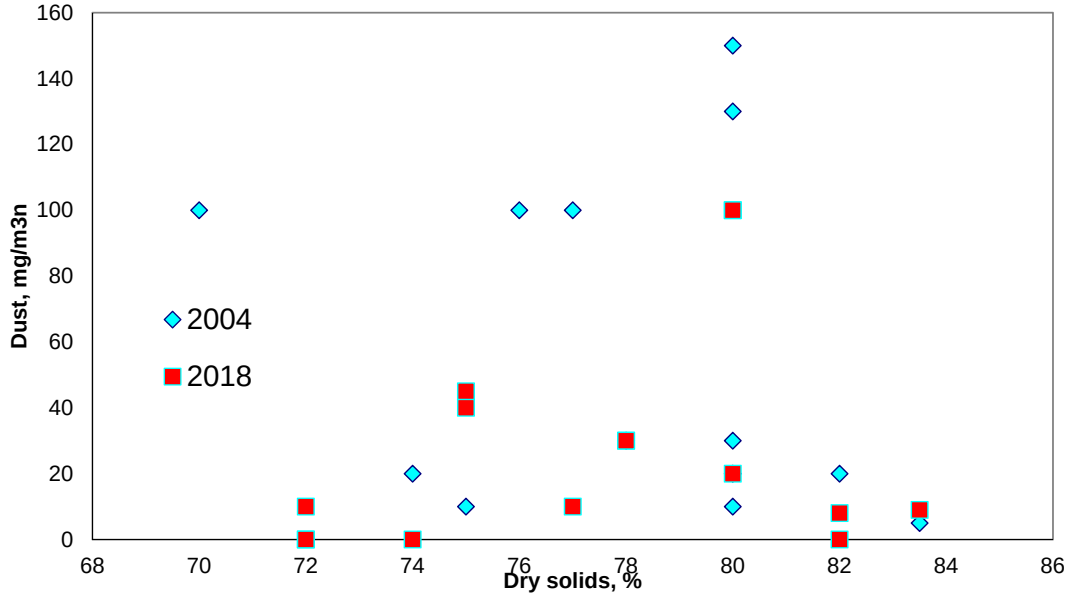
Recovery boiler dust



Dust emissions decreased

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Conclusions

- Bigger boilers firing
- lower heating value liquor at
- higher dry solids
- with higher furnace loading
- due to lower primary air and
- more tertiary and quaternary air
- and maintaining low emissions

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