Deposit Control Technology for Kraft Recovery Units

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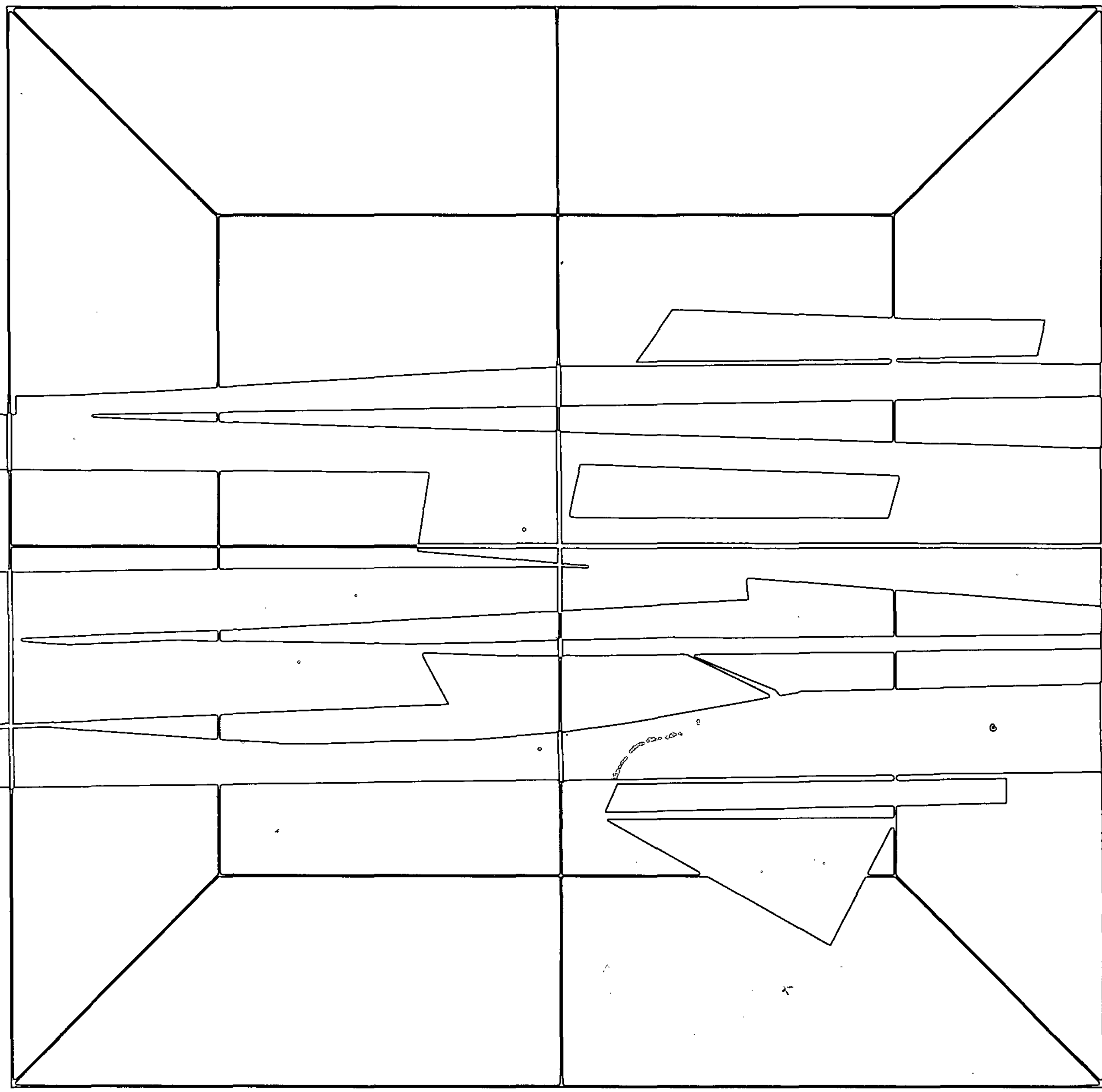
December 1984



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DEPOSIT CONTROL TECHNOLOGY FOR KRAFT RECOVERY UNITS

by

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for the

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Environmental Protection Service
Environment Canada

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December 1984

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ABSTRACT

This report describes the development of an on-line instrument for measuring the rate of accumulation of fireside deposits in the superheater and boiler sections of kraft recovery units. Massive accumulations of fireside deposits plug flue gas passages and ultimately limit kraft recovery unit capacity and pulp mill production. The instrument developed, named sootprobe™, offers the opportunity for increased pulp production through improved deposit control. It is estimated that, in a nominal 750-t/d kraft mill, use of this technology would result in an incremental pulp production of $2 600 000 per year, and that this would be accompanied by an energy saving of $200 000.

Results of three trials of the research models of sootprobe™ at a kraft mill in Ontario show that:

1) The accumulation of deposits in the superheater and boiler bank regions in kraft recovery units can be continuously measured using sootprobe™.
2) The signal from sootprobe™ is reliable.
3) sootprobe™ can be used to monitor flue gas temperatures.
4) Deposit accumulation rates in the superheater and boiler bank regions vary significantly at the same black liquor firing load.
5) sootprobe™ will provide a signal for feedback to the boiler operator so he can adjust firing conditions to minimize deposit accumulation rate.

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1 INTRODUCTION

1.1 Kraft Recovery Units

Kraft pulping is the most important chemical pulping process in the pulp and paper industry. The process uses an aqueous solution of NaOH and Na_2S as cooking liquor to fiberize the wood by dissolving the lignin in a digester at high temperature and pressure. The resultant pulp is filtered, washed, bleached and used to make paper and other products. The spent pulping liquor, called "black liquor" because of its colour, is concentrated to about 65% dissolved solids and burned in a recovery unit (Figure 1). The recovery unit has three main functions: eliminating, through combustion, the lignin and other wood components dissolved in the black liquor; recovering and regenerating the inorganic pulping chemicals; and, producing steam for power generation and process heating.

Kraft recovery units are of vital importance to the productive capacity, energy efficiency, environmental impact and capital cost of kraft pulp mills. Recovery unit capacity, and therefore pulp production, is ultimately limited by massive accumulation of fireside deposits. The deposits cause many problems, including decrease of heat transfer efficiency, increased corrosion of superheater and boiler tube metal and plugging of flue gas passages. Massive deposit accumulation can lead to a complete blockage of the boiler, causing significant production losses associated with unscheduled shutdowns.

1.2 Occurrence of Fireside Deposits

Fireside deposits in kraft recovery units result from the high inorganic content of black liquor, which accounts typically for 35-45% of black liquor dry solids. Deposits are formed by two distinctly different mechanisms: 1) the impingement of carryover particles on heat transfer surfaces (carryover), and 2) deposition by condensed vapours of compounds volatilized in the lower part of the unit (condensation). In the lower superheater region, particularly on the windward side of the tubes, the carryover mechanism is dominant, forming hard and thick deposits. In the upper superheater region, generating section and economizer, deposits are formed mainly by condensation and, under normal conditions, are white, friable, powdery and easy to remove.

The chemistry, morphology, thermal and mechanical properties, and mechanism of deposit formation have been intensively studied at the University of

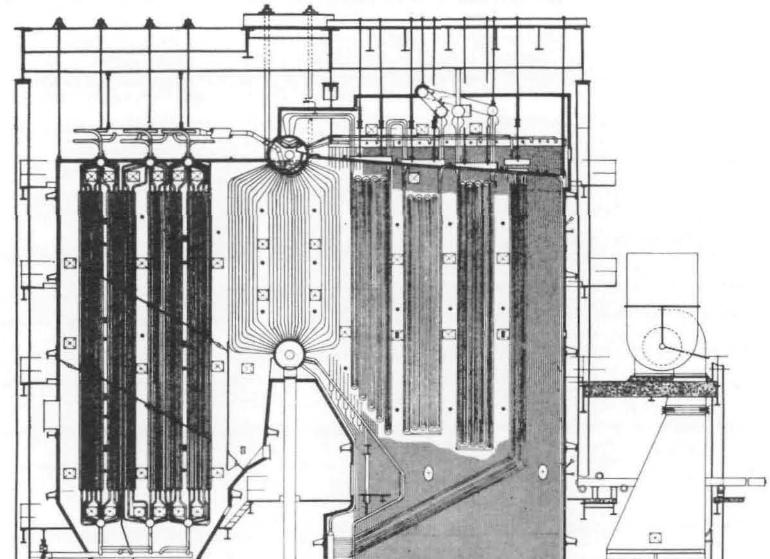


FIGURE 1 KRAFT RECOVERY UNIT

Toronto in the last five years (1-3). These fundamental studies have resulted in a deeper understanding of deposit characteristics and their effect on superheater corrosion (2,4,5) and flue gas passage plugging (6).

2 CURRENT METHODS FOR CONTROLLING DEPOSITS

2.1 Sootblowers

Deposit accumulation is controlled by sootblowers which inject high pressure steam through small rotating nozzles to dislodge deposits from heat transfer surfaces. Sootblowers are operated on various frequencies depending on the location and boiler operating conditions, with guidance from draft loss and flue gas temperature measurements.

Sootblowers are generally quite effective in the removal of friable and powdery condensation deposits. However, they are not effective against the hard and tenacious carryover deposits, particularly when molten phases are involved.

In units which experience serious plugging problems, the control of massive deposit accumulation by additives has sometimes been attempted. Additives are believed to modify deposit chemistry, decrease deposit stickiness and tenacity and improve the deposit removal efficiency of sootblowers. The results, however, have not been conclusive.

2.2 Deposit Monitoring

Deposit accumulation is measured indirectly by pressure drop or draft loss across the superheater, boiler bank and economizer. However, the measurement generally responds crudely to the massive build-up of deposits. When the pressure drop becomes abnormally high, it is often too late to take any preventive action because most of the flue gas passages will already be blocked and the deposits will have become resistant to sootblowing.

More recently, computer control systems have been developed to optimize sootblowing. Deposit accumulation is monitored by draft loss or gas temperature drop or heat transfer into the water in the economizer or into the steam in the superheater. All these measurements, however, give only crude indications of deposit accumulation, particularly in large boilers.

2.3 Economic Impact of Improved Deposit Control

Improved deposit control would produce: 1) lower sootblower steam requirements; 2) fewer forced shutdowns for recovery unit washouts; 3) improved recovery unit thermal efficiency; and 4) higher recovery unit capacity and thereby higher pulp production capacity.

Sootblowers typically consume 6% of a recovery unit total steam production. A 20% decrease would save each mill \$200 000 per year.

Deposit plugged boilers must be shut down and washed out, resulting in up to two days lost production. The lost revenue for a 750 t/d kraft mill is about \$300 000 per shutdown.

In many mills where there is only one production line, the recovery unit is the bottleneck to production. Incremental capacity is increasingly important because the cost of new capacity has dramatically increased and wood supplies dictate incremental mill expansion rather than new site development. There are many reasons for unit capacity limits but one of the most important is flue gas passage plugging. Increased liquor load fired in the recovery unit increases deposit formation. Further, the higher flue gas temperature resulting from increased liquor load often leads to rapidly accelerated plugging. A 5% increase in the capacity of a 750-t/d mill would increase revenue by about \$2 600 000 per year.

In some cases the recovery unit heat transfer surfaces are insufficient to extract the desired amount of heat from the flue gas, sending hotter gas than necessary up the stack. A 1% increase in the thermal efficiency would produce an additional \$200 000 steam per year for an average sized mill. Further, in the long range, improved deposit control could significantly reduce the heat transfer surface required, making recovery units smaller and cheaper.

There are about 770 kraft recovery units in the world, and more than half are located in North America (7). In Canada there are about 75 recovery units in 51 kraft mills. If 20% of the mills in Canada could improve their deposit control technology as described above, the saving would be \$2 000 000 per year in steam or increased revenue of \$3 000 000 per year due to fewer forced shutdowns, or increased revenue of \$27 000 000 through incremental pulp production capacity.

3 DEVELOPMENT OF NEW DEPOSIT CONTROL TECHNOLOGY

Until now, no direct means of measuring deposit accumulation in kraft recovery units has been available. The boiler operator has no idea how much carryover there is in the upper part of his boiler at a particular time. This information is particularly important because short-term variations in the boiler operation can have a dramatic effect on boiler plugging. Episodes of high carryover and/or high temperature can quickly plug a boiler.

Douglas Reeve & Associates, through the unsolicited proposal program of Supply and Services Canada and financial support from Environment Canada, Environmental Protection Service, is developing new deposit control technology using sootprobe™, an on-line instrument for measuring the rate of accumulation of fireside deposits in the superheater and boiler sections of kraft recovery units. The sootprobe™ provides, on a continuous basis, the deposit accumulation rate and the flue gas temperature in the superheater and boiler bank regions of recovery units.

Three trials in a recovery boiler at a kraft pulp mill in Ontario to test the performance of the experimental model of sootprobe™ have been completed. The first trial was performed in September 1983. The second trial was performed in November 1983. In these two trials, most experiments were performed in the superheater region. The third trial was completed in March 1984. In this trial, the experiments were concentrated at the boiler bank inlet.

3.1 sootprobe™ Design and Installation

Figure 2 shows the experimental sootprobe™ and its cooling air flow control instrumentation scheme. The installation sites for the sootprobe™ are sometimes limited to the number and availability of the openings of the recovery unit. In these trials, the sootprobe™ was installed at three locations, one in the lower superheater region and two in the generating section as shown in Figure 3.

The exposure time of the probe varied from 15 minutes to 24 hours. Most experiments, however, were two hours. After each experiment, the probe was taken out of the furnace and photographed. The deposit thickness was measured and the probe was cleaned.

The boiler operating conditions during these trials are summarized in Table 1. There was no significant change in boiler operating conditions other than a slightly higher

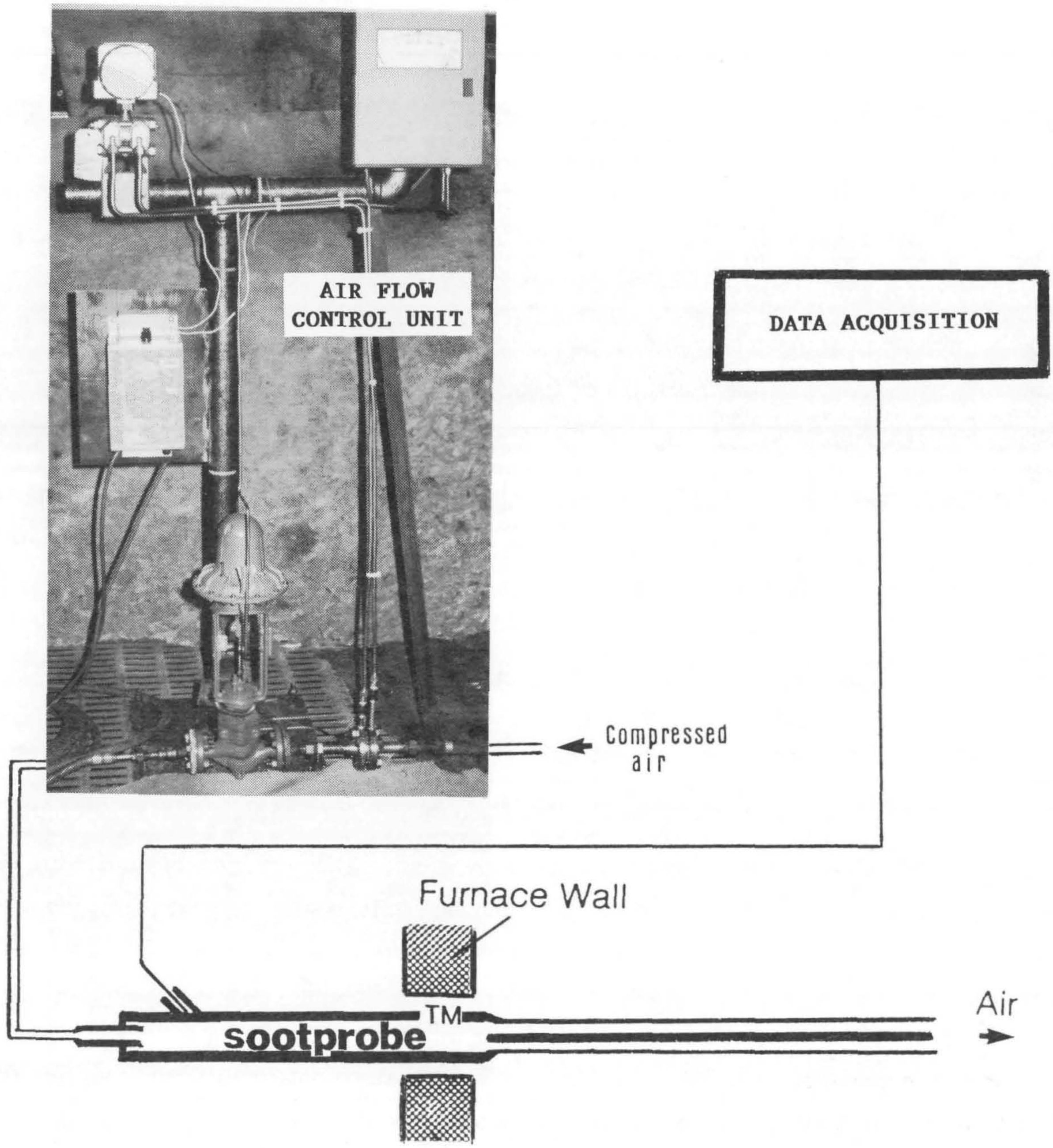


FIGURE 2 sootprobe™ AND CONTROL INSTRUMENTATION

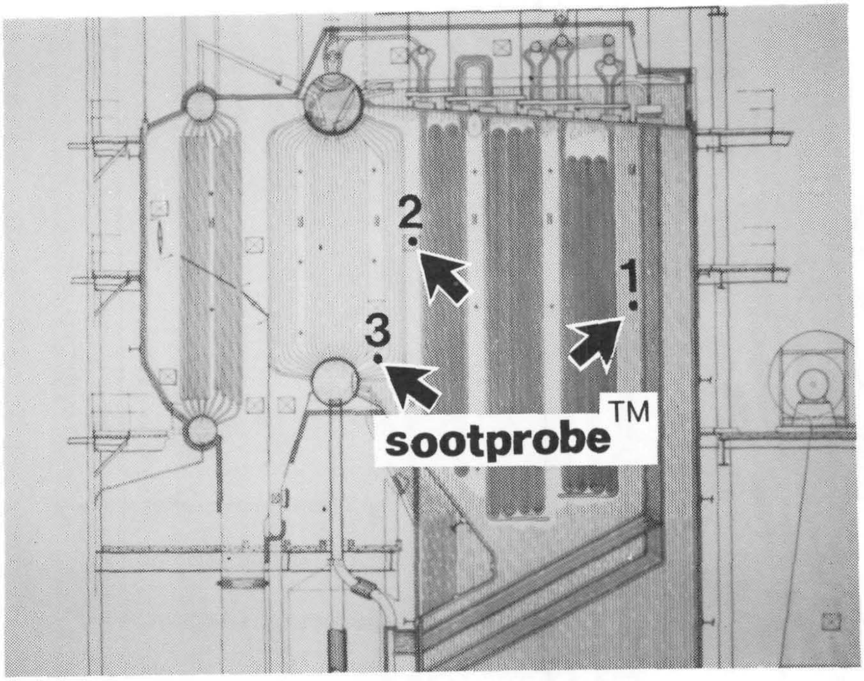


FIGURE 3 LOCATIONS OF sootprobe™ IN THE RECOVERY UNIT

1. Superheater
2. Boiler Bank Inlet
3. Boiler Bank

black liquor load, 908 L/min, during the third trial compared to 852 L/min during the first and second trials.

The trial results are summarized in Table 2.

3.2 sootprobe™ in the Lower Superheater Region

3.2.1 The Flue Gas Temperature. The flue gas temperature in recovery units varies greatly. In the lower superheater region of this particular unit, the average flue gas temperature ranges from 650°C at low load (683 L/min) to about 780°C at high load (870 L/min).

Figure 4 shows the flue gas temperature in the lower superheater region during a two-hour run (experiment no. 26). The flue gas temperature was measured using a flue gas temperature measuring probe located adjacent to the sootprobe™. During this experiment, the boiler was firing 833 L/min black liquor. The flue gas temperature was relatively constant, about 700-750°C. The low temperature recorded around 30 minutes was due to an upset in the lower furnace when no liquor was fired because of plugged liquor lines.

TABLE 1 AVERAGE BOILER OPERATING CONDITIONS DURING TRIALS

	First Trial (Sept. 23-30/83)	Second Trial (Nov. 11-22/83)	Third Trial (March 1-15/84)
Black Liquor			
Firing rate (L/min)	871	852	908
Solids (% dry)	60	62	63
Heating Value (kJ/kg dry solids)	14 886	-	-
Nozzle pressure (kPa gauge)	117	110	110
Nozzle temperature (°C)	125	125	124
Air			
Primary air flow rate (Arbitrary)	150	140	130
Total air flow rate (Arbitrary)	260	250	270
Temperature (°C)	111	108	119
Steam			
Temperature (°C)	486	480	480
Pressure (kPa gauge)	6 070	5 930	5 930
Production (kg/h)	122 470	113 400	113 400
Flue Gas Temperature (°C)			
Superheater	789	766	766
Boiler bank inlet	-	-	589
Boiler bank outlet	-	-	374
Economizer outlet	-	-	363

In some experiments, however, significant short-term variation in the flue gas temperature was observed. Figure 5, for instance, shows a large fluctuation of flue gas temperature during a three-hour run (experiment no. 47) while the unit was firing a constant black liquor load of 908 L/min.

3.2.2 The sootprobe™ Response Signal. The sootprobe™ responds to deposit accumulation by providing a signal which corresponds to the thickness of deposits accumulated on the probe. The thicker the deposits, the greater the response becomes. Figure 6 shows the response of the sootprobe™ during experiment no. 47. The response increases with time as the deposit accumulates. Figure 7 shows the appearance of the probe after this three-hour experiment. The leeward side had only a thin layer (less than

TABLE 2 SUMMARY OF TRIAL RESULTS (L/min)

Expt. No.	Date	Time Start	Location	Black Liquor Flow Rate (L/min)	Dry Solids (%)	Time of Exposure (hours)	Deposit Thickness (mm)	Σ
Trial 1								
1	830923	11:44	SH	871	63.5	18.5	-	85
2	830923	16:15	SH	833-871	63	17	22	70
3	830924	12:16	SH	833	63	1	5	30
4	830924	12:16	SH	833	63	5.5	-	55
5	830925	13:13	SH	833	63	2	-	40
6	830926	12:49	SH	889	63.5	3	-	60
7	830927	11:49	SH	871	64.5	2.3	7	45
8	830928	9:47	SH	700	64.5	2	7	-
9	830928	12:27	SH	889	63	2	8	60
10	830929	9:27	SH	889	64	2.5	9	50
11	830929	16:09	SH	889	61	1	4	40
12	830929	16:09	SH	871-908	62	8	21	90
13	830930	12:43	BB	-	-	8	-	75
14	830930	9:29	SH	-	-	4	11	70
Trial 2								
16	841111	19:50	SH	833-871	62	12.75	19	110
17	831112	11:25	SH	719-795	63	1.75	2.3	20
18	831114	10:36	SH	833	61	3.5	17	90
19	831114	15:08	SH	833	63	2.0	17	70
20	831114	17:34	SH	833	63	1.0	10	50
21	831115	10:47	SH	871	62	0.5	6.5	35
22	831115	11:15	SH	871	62	0.25	2	30
23	831115	12:26	SH	871	62	1.5	14	-
24	831115	14:34	SH	908	62.5	2	9	55
25	831115	17:12	SH	889	61.5	2	15	60
26	831120	9:00	SH	871	63	2	8	55
27	831120	12:00	SH	871	61.5	2	9.5	70
28	831120	14:50	SH	871	61.5	2	6	55
29	831120	17:50	SH	833	61.0	0.5	5	-
30	831120	19:09	BB	833	61	2	-	35
31	831121	11:09	SH	871	61	1.75	0-0.5	10
32	831121	13:52	SH	871	62	2	5.5	35
33	831121	16:37	SH	852	61	4.3	8.5	50
34	831121	22:26	BB	852	60.5	2.5	-	-
35	831122	9:40	SH	833	61	2.5	8	40
Trial 3								
36	840303	17:24	SH	908	63.0	2	15	110
37	840304	20:22	SH	908	61.5	1	4	55
38	840304	9:27	SH	908	61.5	2	11	100
39	840304	12:12	BBI	908	62	3	<1	15
40	840304	12:12	BBI	908	62	22	8	70
41	840305	11:04	BBI	908	63	5	2	30
41a	840305	11:04	BBI	908	63	11	6	60
41b	840305	11:04	BBI	908	63	23.5	7	65
42	840306	17:23	BBI	568-871	63.5	18.6	-	65
43	840307	16:37	BBI	871	-	17	6	50
44*	840308	11:30	BBI	-	-	5.5	6	-
45	840308	17:05	BBI	643-833	62	16	2-3	25
46	840309	11:07	SH	908	63.5	2	5	40
47	840309	14:07	SH	908	62.5	3	10	85
48	840309	17:16	SH	568-908	63.1	-	-	-
49	840311	8:52	BBI	908	60.5	3	1	20
49a	840311	8:52	BBI	908	62	8.4	1	20
49b	840311	8:52	BBI	908	62	24	16	80
50	840312	10:12	BBI	908	62	1.5	3	30
50a	840312	10:12	BBI	908	62	5.8	19	85
51	840312	16:36	BBI	908	62.5	1	5	50
51a	840312	16:36	BBI	908	62.5	17	24	120
52	840313	10:37	BBI	908	63	0.5	<1	25
52a	840313	10:37	BBI	908	63	1.4	4	45
52b	840313	10:37	BBI	908	63	4	8	65
53	840313	15:12	BBI	927	63.5	0.83	4	40
54	840313	16:42	SH	927	63.0	0.33	<1	0
55	840314	10:27	SH	871	66	1	4.5	40
55a	840314	10:27	SH	871	66	1.4	5	45

Remarks
Σ: Total Response of sootprobe™
SH: Lower Superheater
BB: Boiler Bank
*: Cooling air off
BBI: Boiler bank inlet
-: Not available

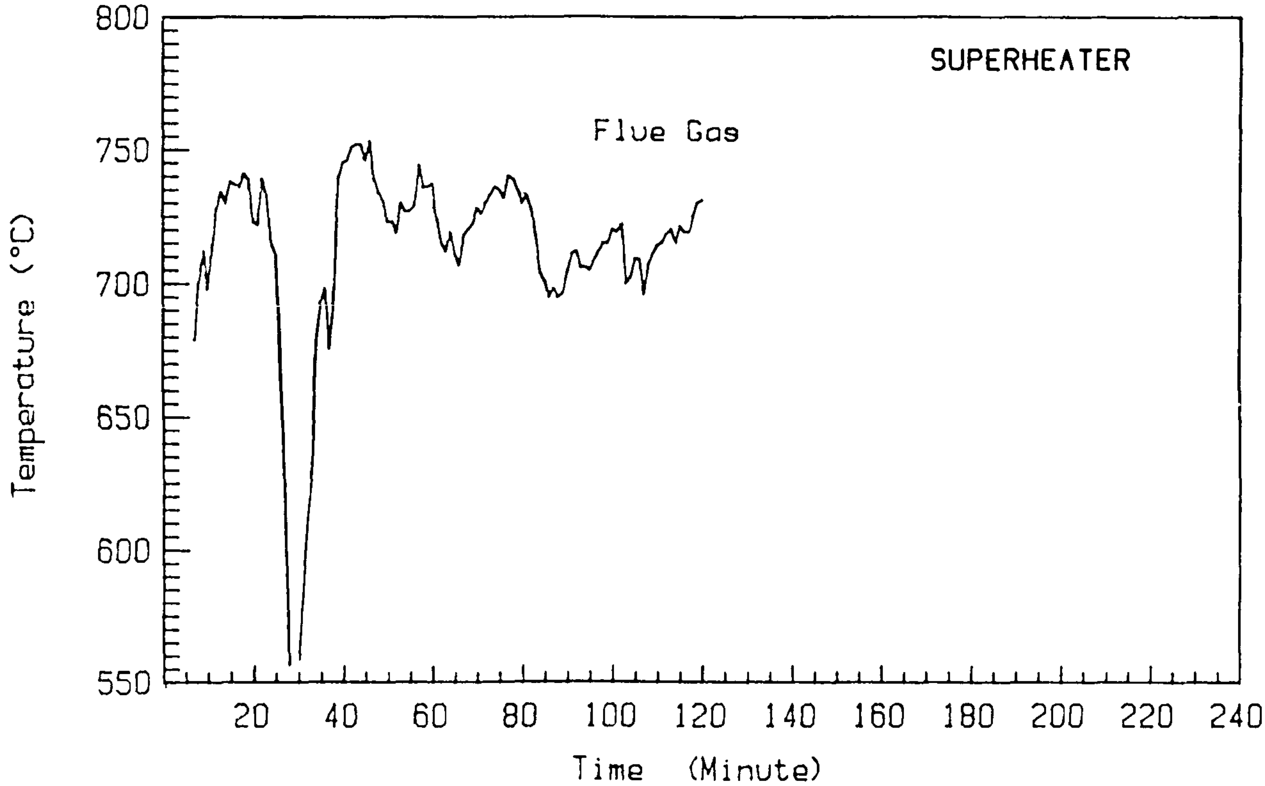


FIGURE 4 FLUE GAS TEMPERATURE IN THE LOWER SUPERHEATER REGION DURING A 2-HOUR RUN (Experiment no. 26)

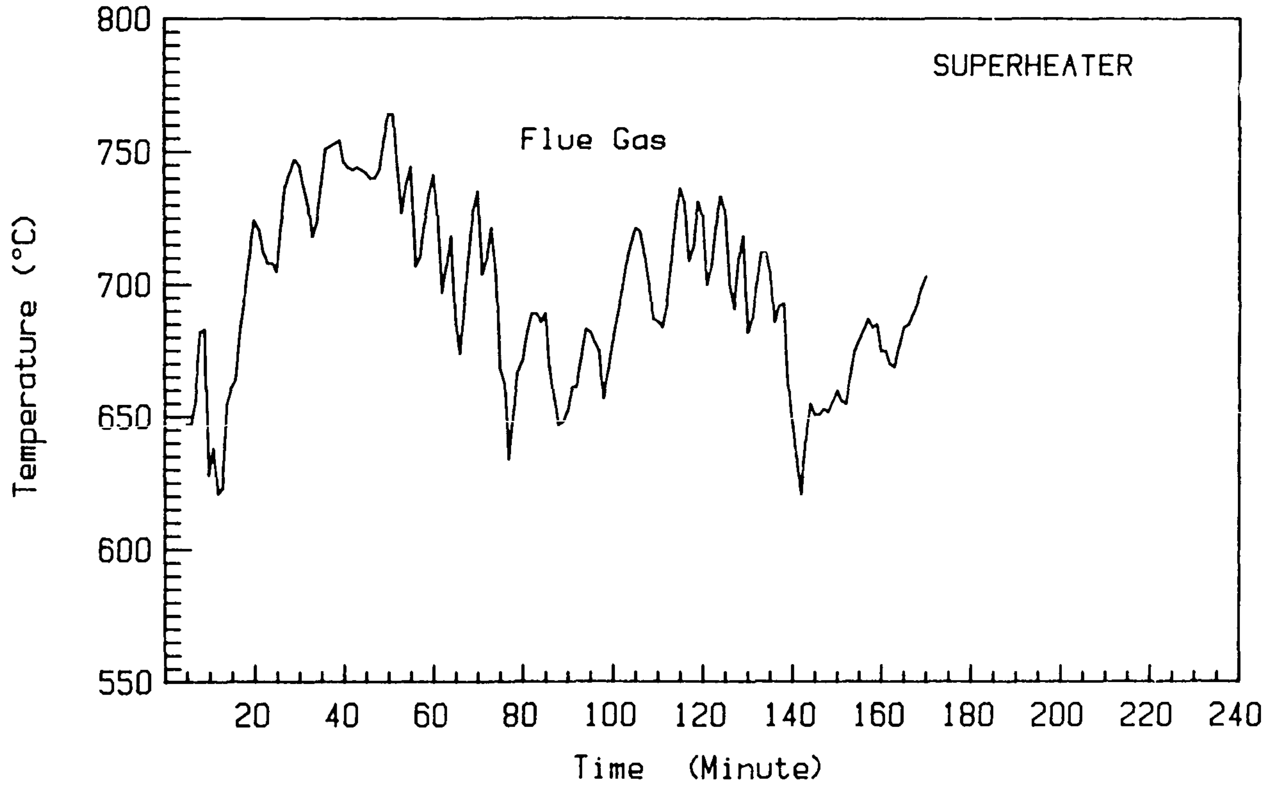


FIGURE 5 FLUE GAS TEMPERATURE IN THE LOWER SUPERHEATER REGION DURING A 3-HOUR RUN (Experiment no. 47)

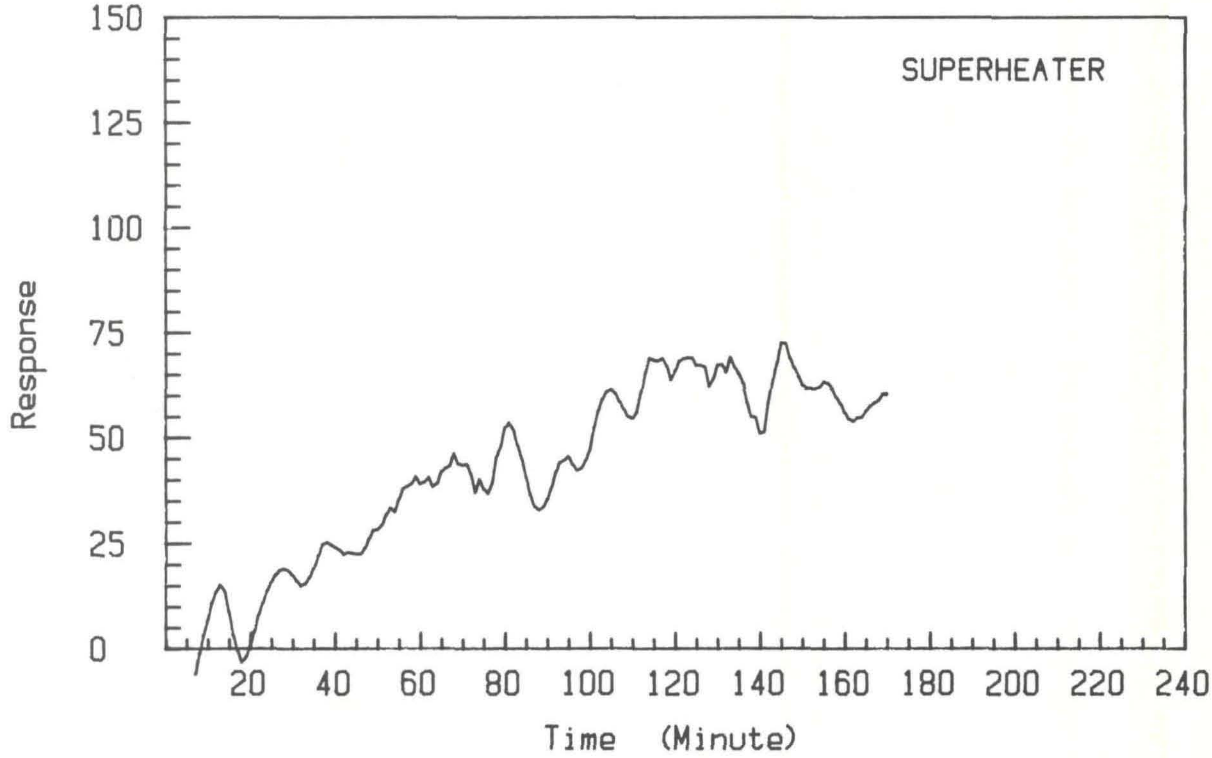


FIGURE 6 RESPONSE OF sootprobe™ DURING A 3-HOUR RUN (Experiment no. 47) IN THE LOWER SUPERHEATER REGION

LEEWARD

WINDWARD

FIGURE 7 DEPOSITS ON sootprobe™ AFTER A 3-HOUR RUN (Experiment no. 47)

0.5 mm) of white powdery deposits, while on the windward side, rough, tenacious, 10 mm thick deposits were found.

In some other experiments, deposits accumulated at much higher rates. During a three-hour run (experiment no. 18), for instance, the response increased dramatically with time (Figure 8). The appearance of the deposits after this experiment is shown in Figure 9. The leeward side deposits were white and thin as observed in the previous experiment but the windward side deposits were pink and much thicker, about 17 mm (Figure 10).

In experiment no. 31, the probe was exposed for nearly two hours while 871 L/min black liquor was fired, a firing rate 20% above the boiler design capacity. There was almost no change in the response, as shown in Figure 11, suggesting that there was no or very little deposit accumulation. This, indeed, was confirmed by examination of the probe after the experiment. Only a very thin deposit was observed (Figure 12). A similar response of sootprobe™ to the deposit thickness was also observed in the generating section, during a different probe exposure.

This response of the sootprobe™ to the deposit thickness (response increases as the deposit accumulates) is of great importance. It indicates that the sootprobe™ provides a reliable signal corresponding to deposit accumulation rates.

3.2.3 The Total Response. The total response Σ at time t is defined as the absolute value of the difference between the initial response and the response at time t, namely,

$$\Sigma = |\sigma_i - \sigma_t|$$

where σ_i and σ_t are respectively the initial response and the response at time t.

Since the total response Σ is relative to the initial response signal and is independent of time, it is a better indication of deposit accumulation than the response signal.

Figure 13 shows the total response in the superheater at the end of each experiment in the first and second trials, plotted against the deposit thickness. Although there is some scatter, the data clearly show that the thicker the deposit is the greater the total response. Similarly, Figure 14 shows the total response of experiments in the superheater in the third trial as a function of deposit thickness.

3.3 sootprobe™ in the Generating Section

In the generating section, the flue gas temperature is lower so the carryover particles contain less molten phase and are not as sticky as in the lower superheater region. Deposits accumulate at a lower rate in this region.

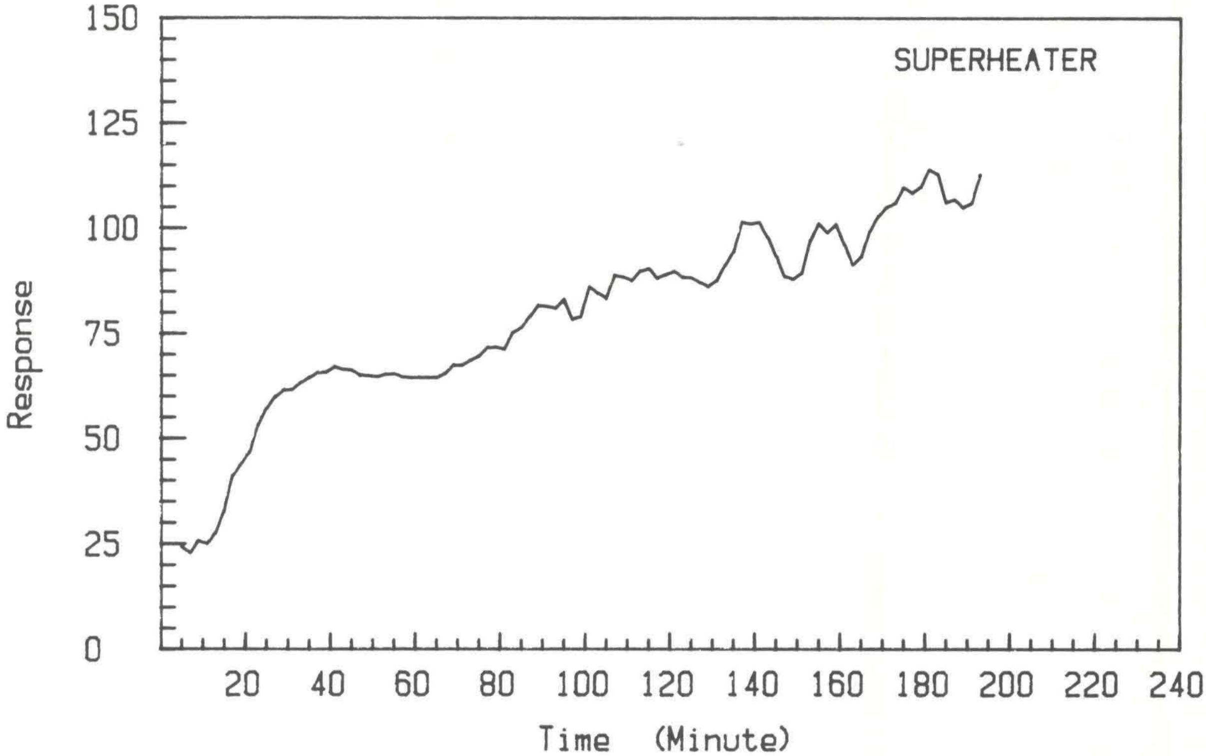
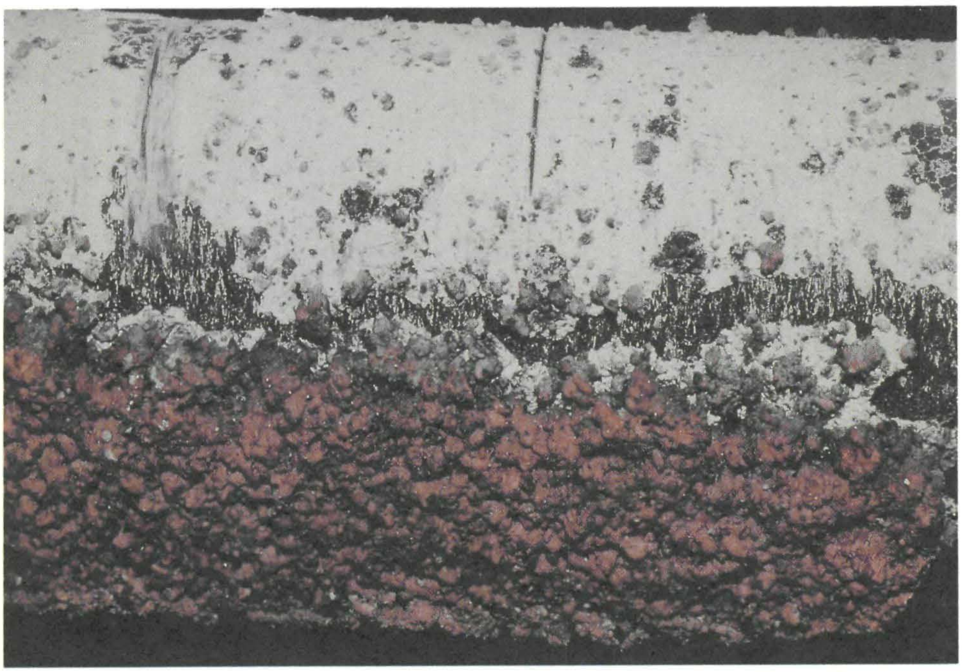


FIGURE 8 RESPONSE OF sootprobe™ DURING A 3-HOUR RUN (Experiment no. 18) IN THE LOWER SUPERHEATER REGION

LEEWARD



WINDWARD

FIGURE 9 DEPOSITS ON sootprobe™ AFTER A 3-HOUR RUN (Experiment no. 18)

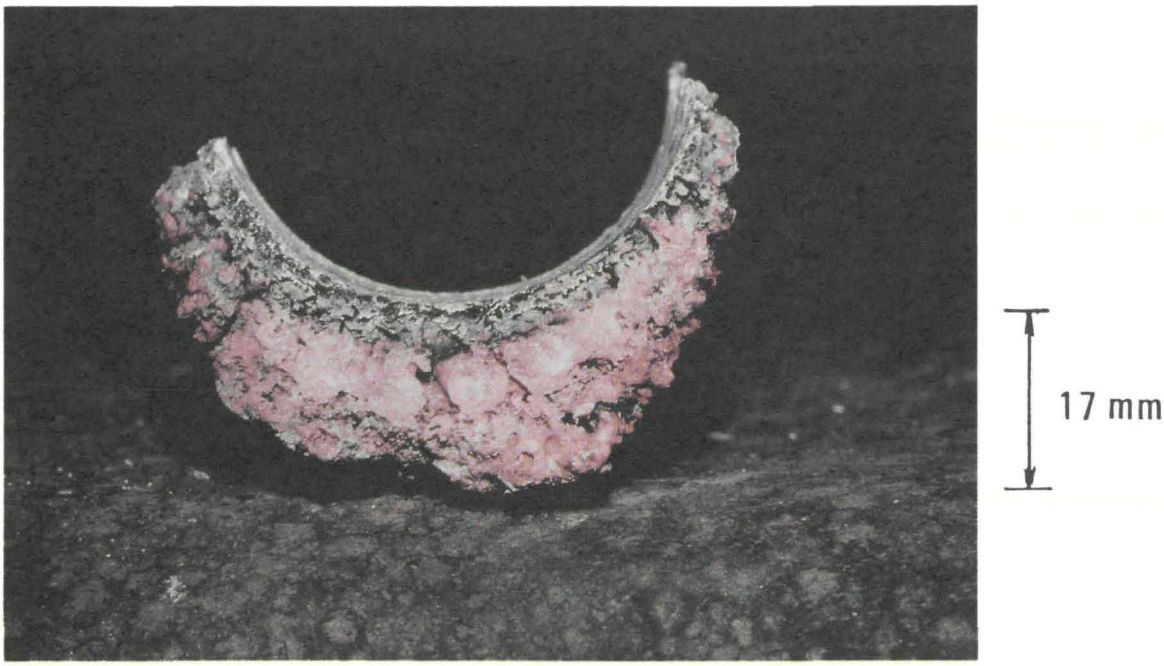


FIGURE 10 CROSS SECTION OF DEPOSITS SHOWN IN FIGURE 9

Most experiments in the generating section were performed during the third trial (Table 4). The operating conditions of the sootprobe™ were adjusted to simulate actual boiler bank tubes. Figure 15 shows the response signal of the sootprobe™ exposed at the boiler bank inlet for 17 hours (experiment no. 51). The signal increased steadily as the deposit thickness increased. The deposit on the windward side of the probe after 1 hour was about 5 mm, and after 17 hours about 24 mm (Figure 16). The total response showed a similar trend, measuring 50 after 1 hour and 120 after 17 hours.

In some experiments, the deposition rate was significantly lower and accordingly the total response was also smaller. In experiment no. 41, for instance, the deposit was only 2 mm thick after 5 hours and 7 mm after 24 hours (Figure 17). The total response was also much smaller, measuring 30 and 65, respectively. This again confirmed that the sootprobe™ provides a reliable signal corresponding to deposit accumulation rates.

Figure 18 shows the total response at the end of each experiment at the boiler bank inlet in the third trial, plotted against deposit thickness. As in the case of the superheater region, the data clearly show that the thicker the deposit, the greater the total response.

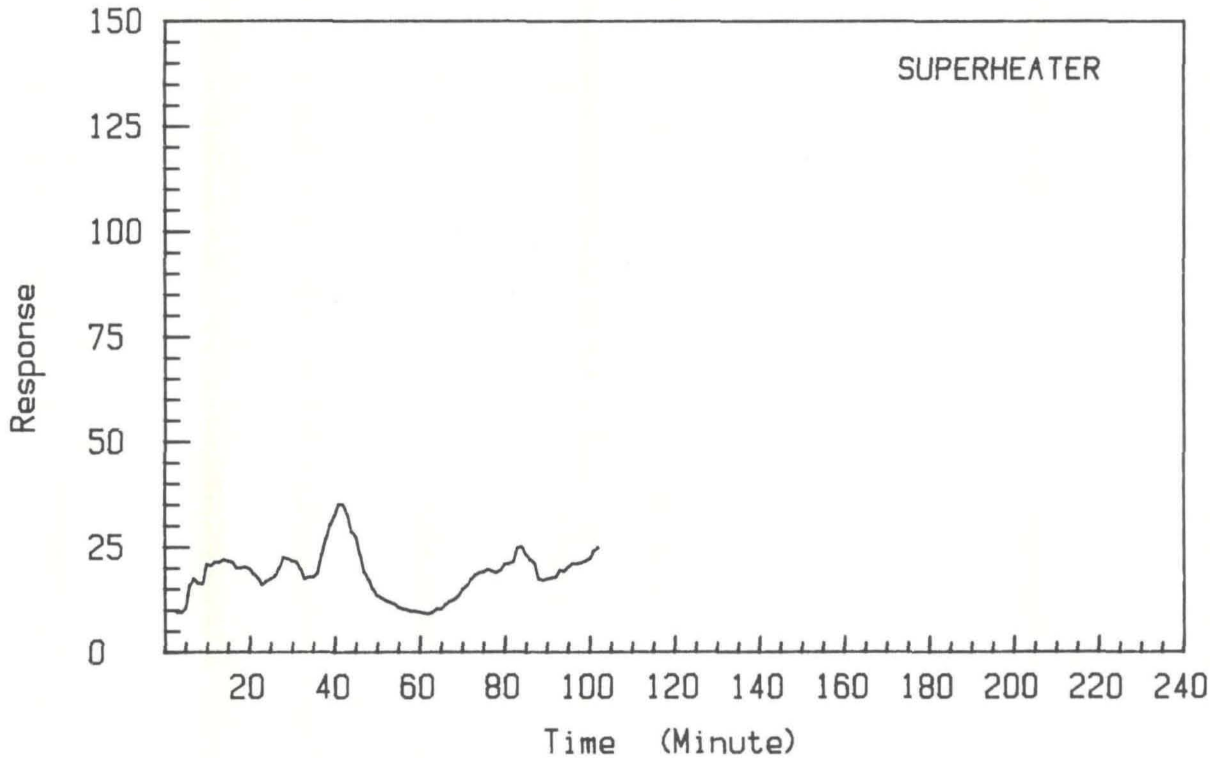
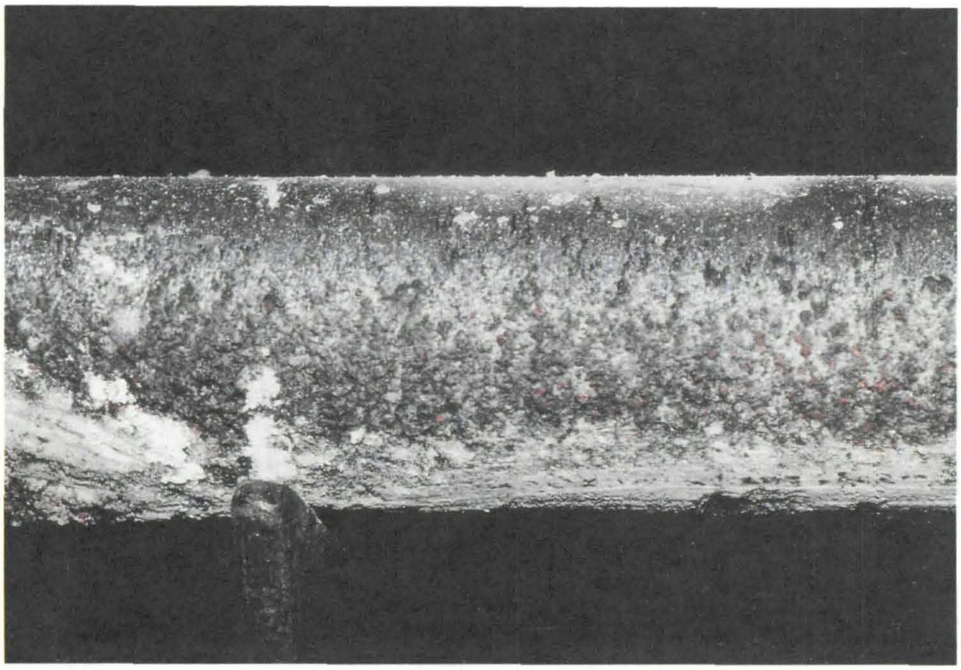


FIGURE 11 RESPONSE OF sootprobe™ DURING A 1.75 HOUR RUN (Experiment no. 31) IN THE LOWER SUPERHEATER REGION

LEEWARD



WINDWARD

FIGURE 12 DEPOSITS ON sootprobe™ AFTER A 1.75 HOUR RUN (Experiment no. 31)

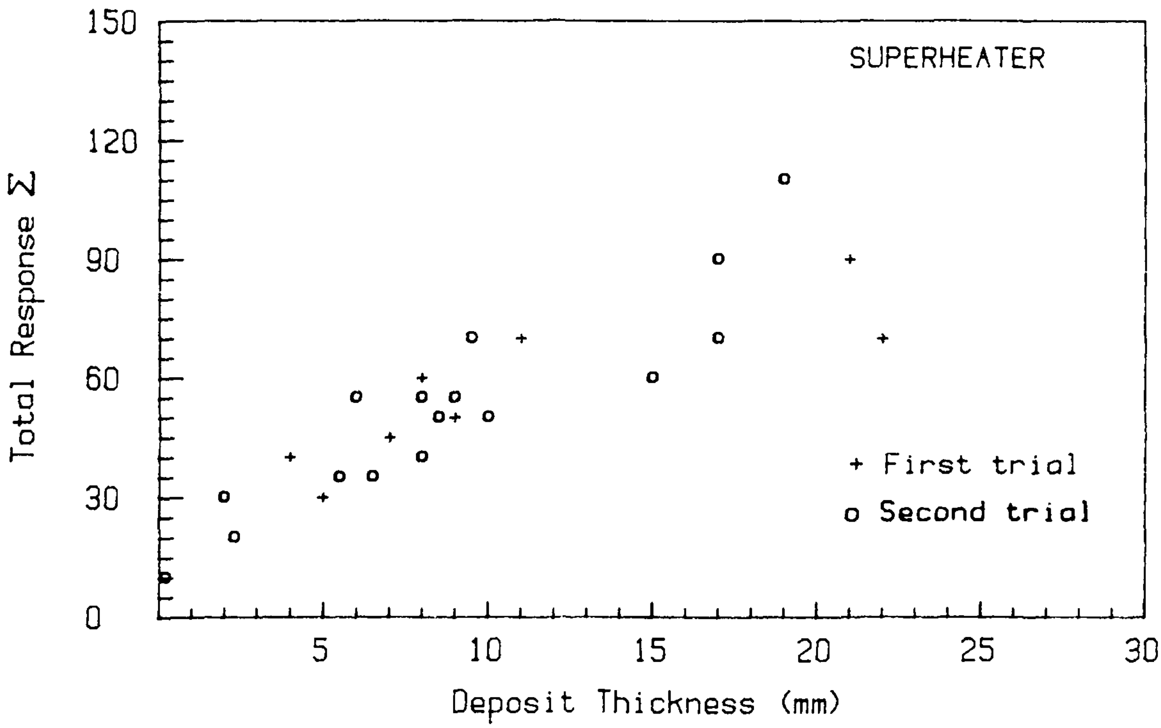


FIGURE 13 EFFECT OF DEPOSIT THICKNESS IN THE SUPERHEATER REGION DURING THE FIRST AND SECOND TRIALS

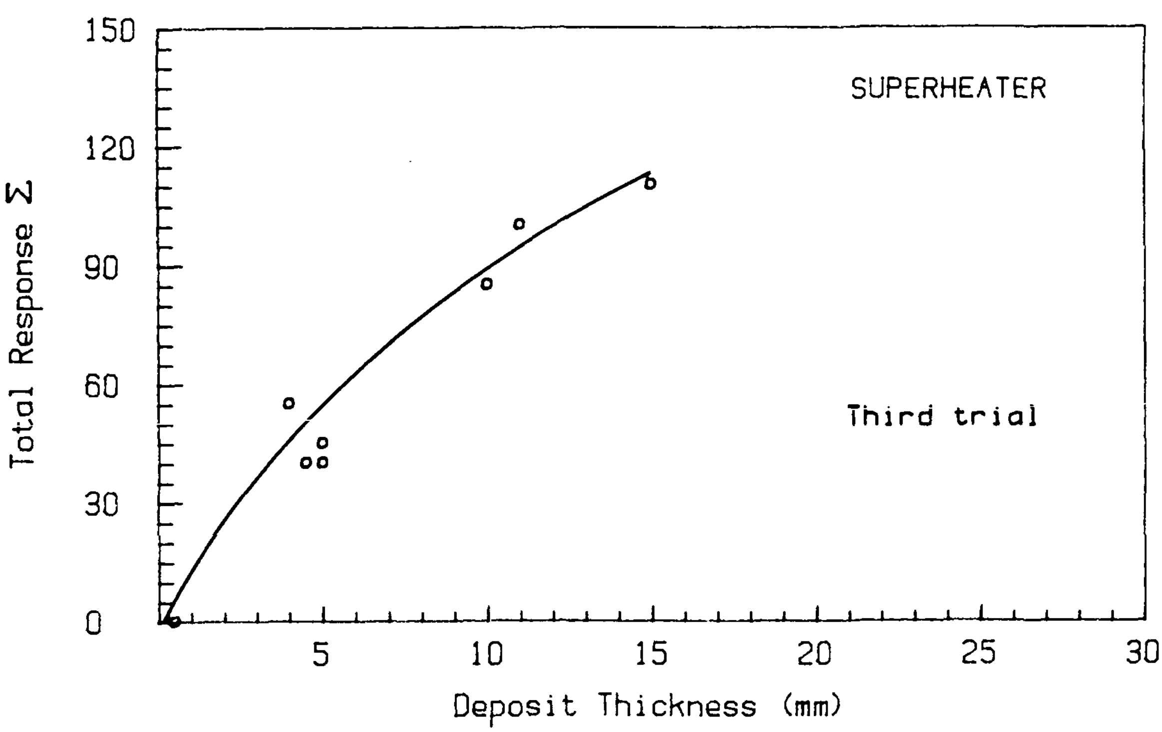


FIGURE 14 EFFECT OF DEPOSIT THICKNESS IN THE SUPERHEATER REGION DURING THE THIRD TRIAL

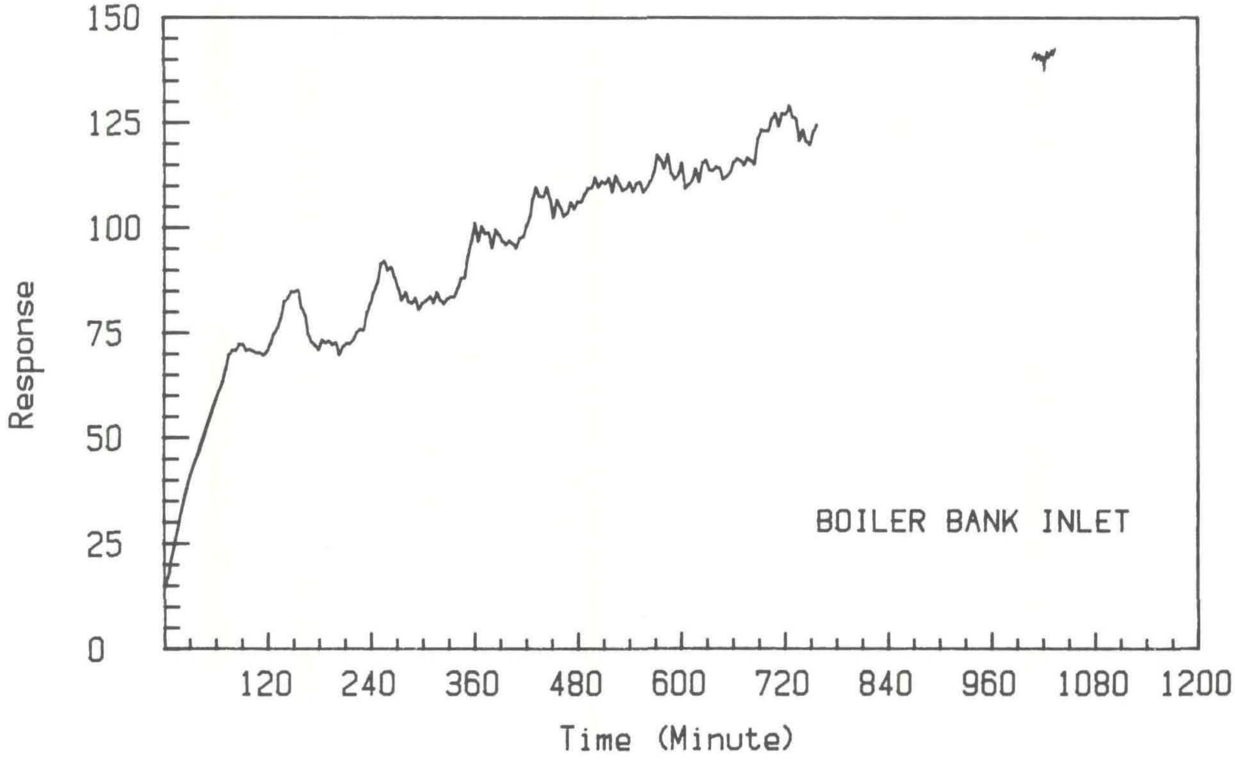
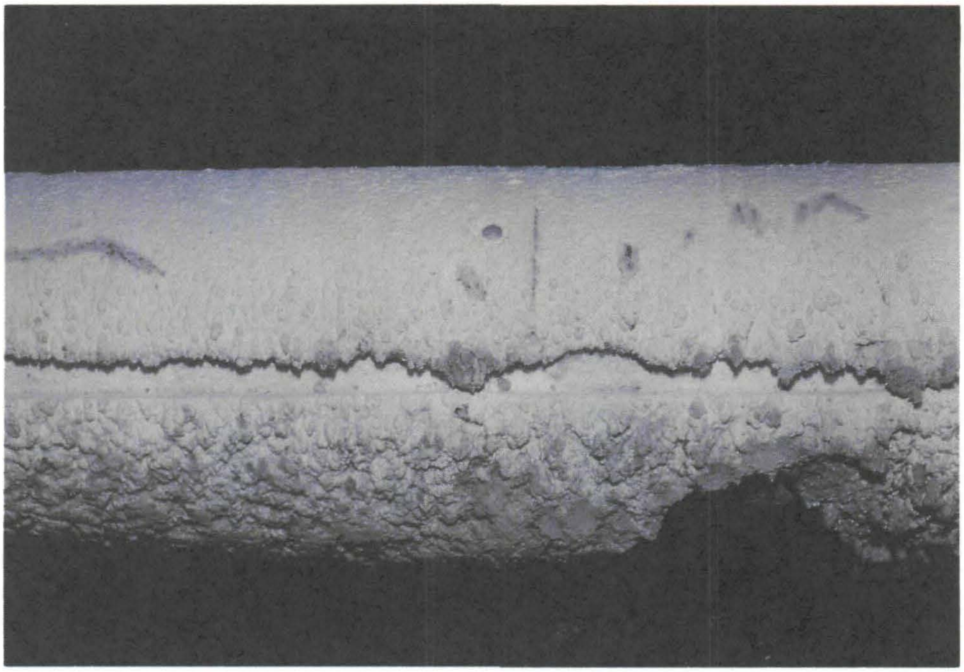


FIGURE 15 RESPONSE OF sootprobe™ DURING A 17-HOUR RUN (Experiment no. 51) AT THE BOILER BANK INLET

FIGURE 16 DEPOSITS ON sootprobe™ AFTER 17 HOURS EXPOSED AT THE BOILER BANK INLET (Experiment no. 51)

LEEWARD



WINDWARD

FIGURE 17 DEPOSITS ON sootprobe™ AFTER 24 HOURS EXPOSED AT THE BOILER BANK INLET (Experiment no. 41)

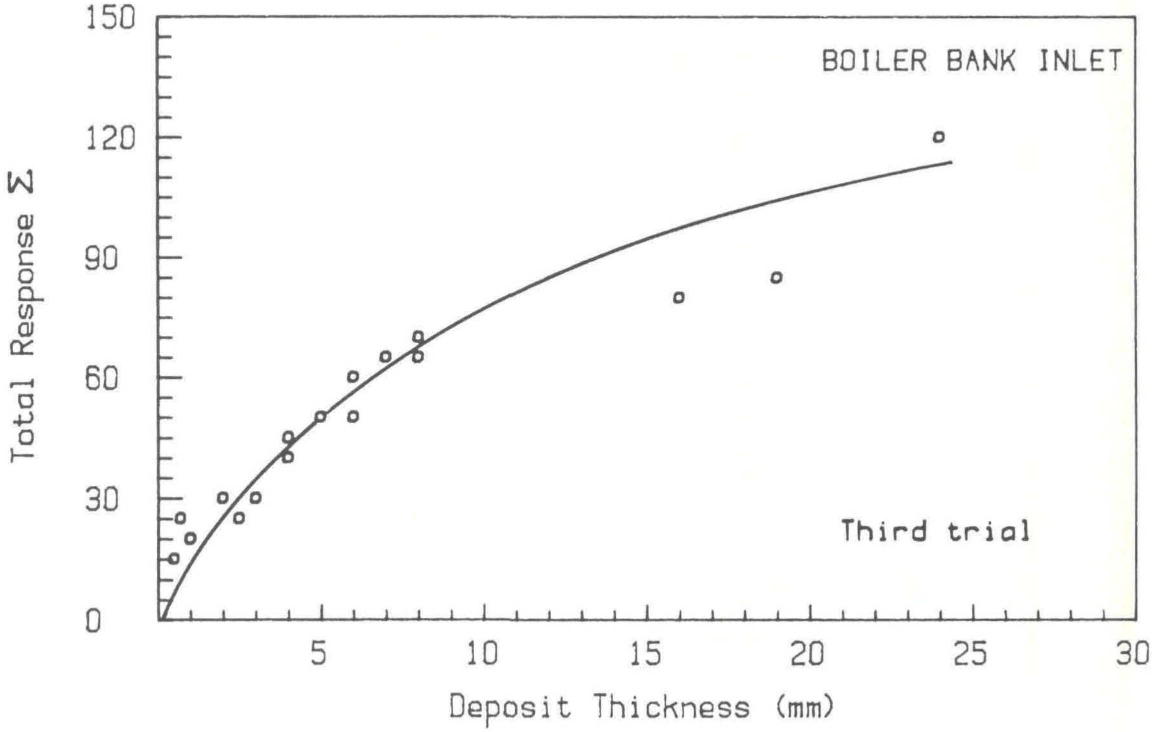


FIGURE 18 EFFECT OF DEPOSIT THICKNESS AT THE BOILER BANK INLET DURING THE THIRD TRIAL

3.4 Measurement of Flue Gas Temperatures Using sootprobe™

Figure 19 shows the flue gas temperature recorded by sootprobe™ along with that measured by the flue gas temperature probe during a three-hour run in the superheater region (experiment no. 47). The results were consistent despite the wide variation of the flue gas temperature during the experiment.

The excellent agreement of the results obtained by the two devices suggests that the sootprobe™ can also be used to continuously monitor flue gas temperatures. This is a very important feature of the sootprobe™. It provides crucial information for recovery unit control technology because high flue gas temperatures have been known to play a significant role in the rapid build-up of deposits that cause boiler plugging. Presently, no continuous measurement of flue gas temperatures prior to the generating section is available because of the highly corrosive and dirty environment. Detection of high flue gas temperature excursions at the boiler bank inlet over short periods of time would provide boiler operators with an opportunity to take appropriate preventive action.

3.5 Variation of Deposition Rate

As shown in Tables 1 and 2, the black liquor firing rate in most experiments was relatively unchanged, at about 833-908 L/min or 20% above the design capacity of the unit based on black liquor solids rating. The deposit accumulation rate, however, varied widely. Figure 20 shows the deposit accumulation rate in the superheater region during the first and second trials. For experiments performed from November 11 to November 15, 1983, the deposition rate was high and the deposit thickness seemed to reach steady state after about four hours. For experiments performed from November 20 to November 22, 1983, the deposition rate was much lower. Further, within two hours, for instance, the deposit accumulation varied from as low as almost 0 to as high as 17 mm.

The third trial results shown in Figure 21 also show a wide variation of deposit accumulation rate in the superheater region, ranging from 5 mm to 15 mm in two hours.

The wide variation in the deposit accumulation rate found at "constant" black liquor firing rate is a very important finding because the black liquor firing load has long been considered the most important parameter affecting the deposit accumulation rate. It clearly suggests that boiler operating conditions other than black liquor firing load can also have a significant effect on deposit accumulation.

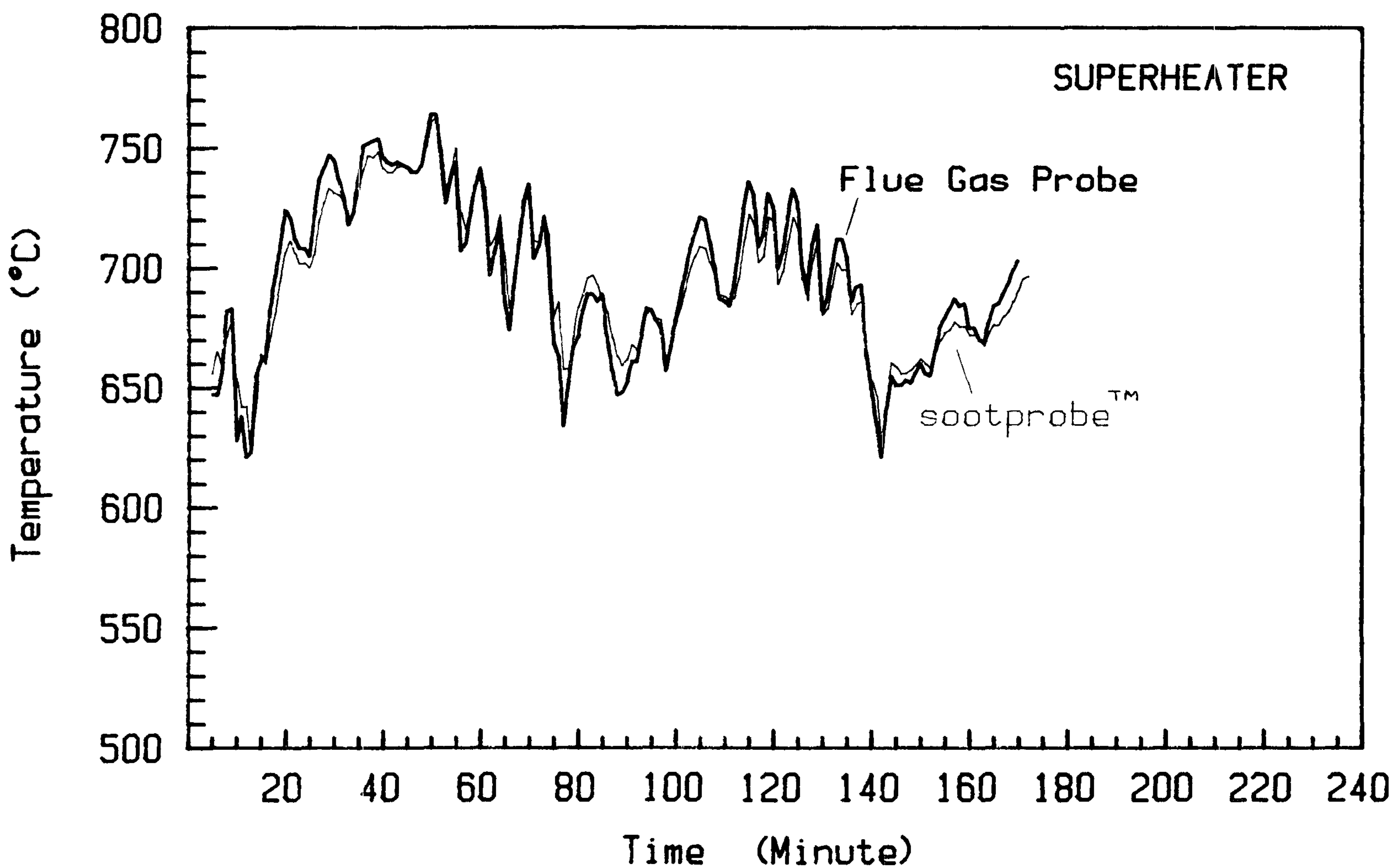


FIGURE 19 FLUE GAS TEMPERATURE DURING A 3-HOUR RUN (Experiment No. 47) MEASURED DIRECTLY AND BY sootprobe™

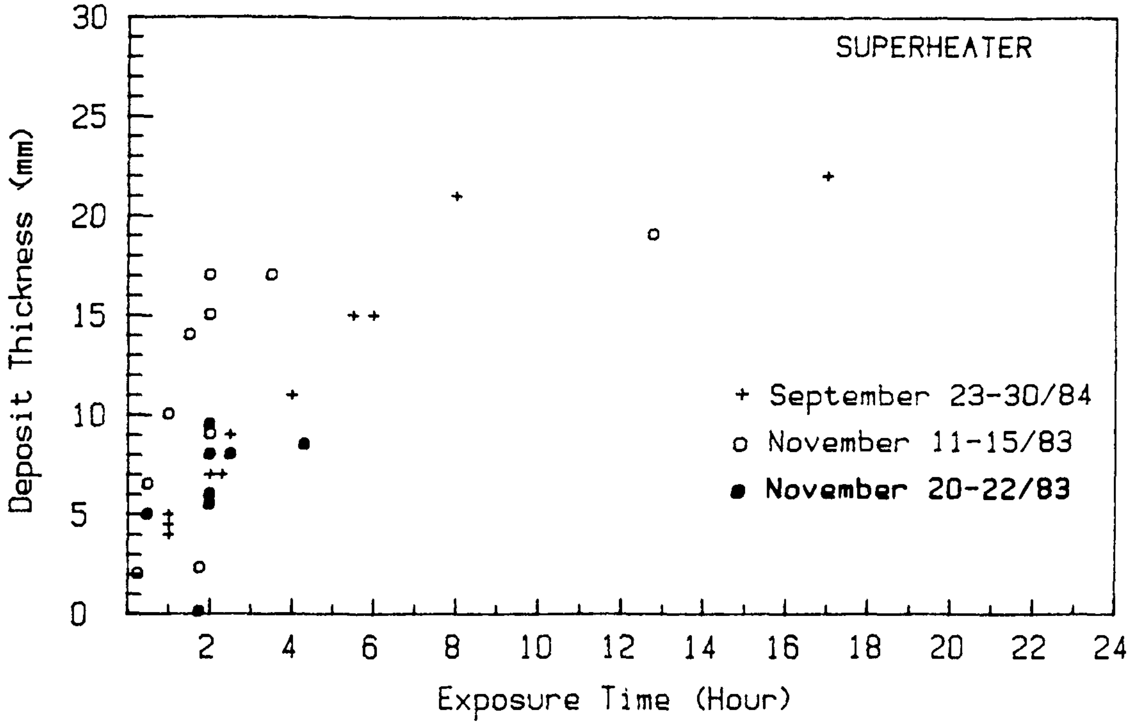


FIGURE 20 DEPOSIT ACCUMULATION ON sootprobe™ IN THE SUPERHEATER REGION DURING THE FIRST AND SECOND TRIALS

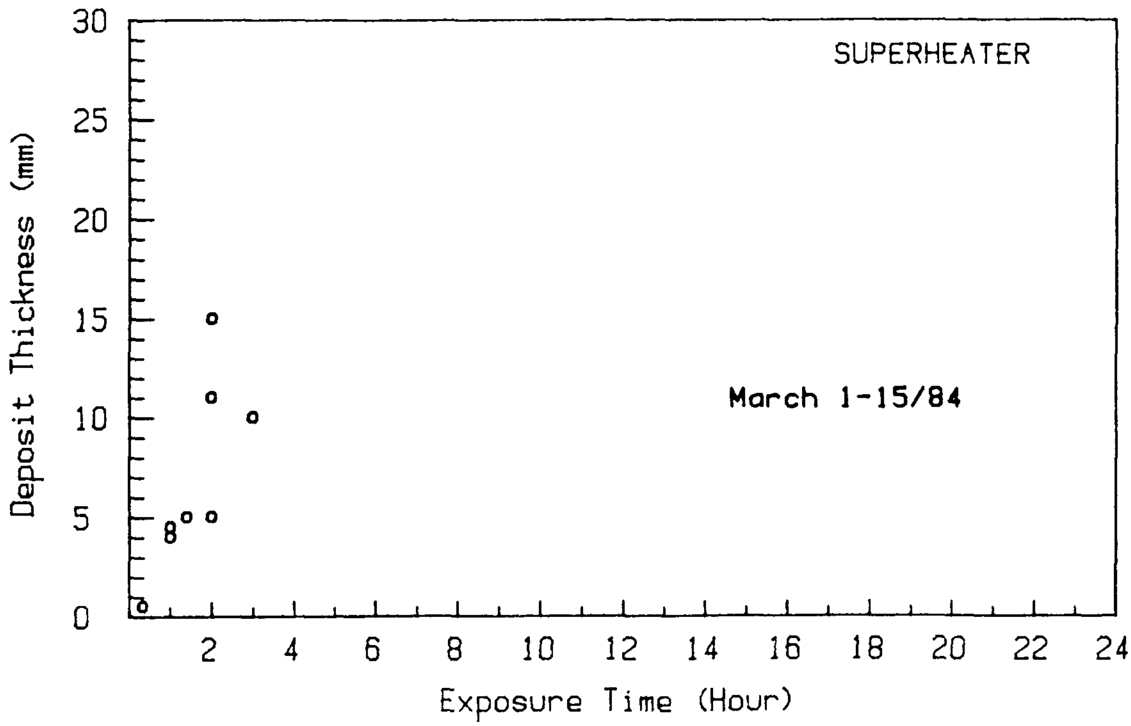


FIGURE 21 DEPOSIT ACCUMULATION ON sootprobe™ IN THE SUPERHEATER REGION DURING THE THIRD TRIAL

4 PRACTICAL APPLICATION OF sootprobe™

Deposit accumulation is a function of many variables which often interact with one another. No single operating variable can be considered as a definite cause of high deposition rate. As a result, the battles against plugging by manipulating one or two variables have not achieved much success. This is mainly because there has been no means of measuring the short-term effects of changing operating conditions.

In addition to the capability to provide boiler operators with deposit accumulation rates and flue gas temperatures continuously, the sootprobe™ can be used as a tool to measure the short-term effect of operating conditions on deposit accumulation rates and flue gas temperatures. Major operating conditions causing plugging in the individual unit can then be identified. The boiler operator can use this information to adjust firing conditions in the lower furnace to minimize deposition.

Industrial and federal government support is being sought to continue the development of the sootprobe™. In the prototype development stage, sootprobes™ will be installed in several kraft recovery units. The prototype will consist of at least two sootprobes™ (one in the superheater region and the other at the boiler bank inlet) operated simultaneously. Deposit accumulation rate and the surrounding flue gas temperature will be monitored using data acquisition coupled with specially designed computer programs. The signals will be displayed on a panel in the recovery boiler control room.

The effect of boiler operating conditions on the deposit accumulation rate will be examined and the use of the sootprobe™ for deposit control technology will be explored. The results are expected to lead to commercialization of the sootprobe™.

5 CONCLUSIONS

The results obtained from the three mill trials of the research model of the sootprobe™ show that:

1) The accumulation of deposits in the superheater and boiler bank regions in kraft recovery units can be continuously measured using sootprobe™.
2) The signal from sootprobe™ is reliable.
3) sootprobe™ can be used to monitor flue gas temperatures.
4) The deposit accumulation rates vary significantly at the same firing load.
5) sootprobe™ will provide feedback to the boiler operator so he can adjust firing conditions to minimize deposition rate.

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