

Field data of PEAM on Boiler application

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Over view of PEAM on Boiler application

Boiler efficiency can be affected by various factors: Size, Model, Fuel spec, Operation load, etc. Also, Operation procedure may affect. The following statements are the points to get the best result of PEAM based on the testimonies of 3 senior boiler engineers of long term PEAM user.

For Heavy oil B & C, it's very important to pay attention to Oil temperature and Oil pressure. (Not much affect on Heavy oil A due to no requirement of heating)

1) Heating temperature

By adding PEAM, the viscosity of Heavy oil will be reduced, therefore there is a possibility of lower down Oil temperature about 10-20C from the normal temperature.

- Seeing suspended Dust -> Temp shall be turned up (max 110C on Heavy oil C)
- Seeing creation of Soot -> Temp shall be turned up to suitable level

The lower down limit of Oil temperature is the level of no creation of soot.

2) Oil level and Oil pressure

By adding PEAM, the smog will be improved; therefore the flow is pretty good even narrowing spray vent. Oil pressure to be reduced the range of 20 to 15 (approx 1/4). Making suitable adjustments (e.g. 6 gallons in winter, 4 gallons in summer)

- Return burner --- by throttle valve
- Plunger burner --- by oil pressure
- Other burners --- by nozzle tip

Consider extending Purge circuit about 5 second in advance to avoid miss-ignition causing by narrowing Oil level.

3) Solenoid valve and Photoelectric cell

By adding PEAM, the malfunction, which caused by adhered slug on the solenoid valve and the relay failure by adhered soot, will be improved, but periodically checking and cleaning are strongly recommended, which also prevent the risk of transformer burned out and miss-ignition.

4) When increasing Soot and Dust

- A) By the effect of PEAM, Slugs and Soot adhesions will be shed off, on Burner, inside of Furnace, Duct and Chimney, then a part of shed off Slugs and Soot stirred up. The increase may occur as a temporary matter but will be ended when the cleaning process is done. (Not common on washed boiler)
- B) In general, vendors tune boiler to set on prior to “less smoke” instead of “combustion efficiency”, and the tuning may become unbalance by the positive effects of PEAM. For this case, narrow down the oil level and increase the air amount, ideally about 7% increase, but the adjustment shall be started from 3% level carefully watching the color of the flame and also the smoke to find a right tuning point of the best combustion efficiency.

5) Clogging Strainer

In some case, a clogging on strainer occurs about 10 days after using PEAM, which is caused by shedding off adhesions, dust and grime, from inside of the fuel tank and the pipe to the strainer. It is differ in degree by case and only a temporally matter. However, it's important to pay attention in the early stage until the shedding off adhesion process is calming down.
(If neglect cleaning, it may case of damaging a pump gear by galling)

Remarks

Generally, the heat temperatures are...

- Heavy oil B for 60-70C
- Heavy oil C for 80-105C

It can be lower down 10-20C by using PEAM. Also, the SO₂ (Sulfur Dioxide) odor of Backfire at ignition will be halved by using PEAM.

General spec of Heavy oil in Japan

Oil category	Heavy oil C		High viscosity Heavy oil C	Asphalt
Viscosity: cSt @50C	>100	100-300	500-1,000	-
S(Sulfur), wt%	1.0-2.0	2.0-3.0	3.0-4.0	4.0<
V (vanadium), ppm	>40	30-50	70-150	150<
Na (natrium), ppm	>40	7-15	40-70	60<
carbon residue content, wt%	5-10	7-15	15-20	20<

Saving fuel effect

1) Test and research on Greenhouse boiler

The test was conducted for 14 days on Greenhouse boiler at a vegetable farm, who owns total 56 lanes of Greenhouse, Section A of 26 lanes and Section B of 30 lanes. Each Section was heated by a same model air heating boiler.

Fuel: Heavy oil B

Section A boiler: heating 26 lanes of 3432m²

Section B boiler: heating 30 lanes of 3696m²

	Section A		Section B
PEAM	without		With PEAM
Lane	26 lane		30 lane
Area	3432m ²		3696m ²
14 days fuel consumption	11,200L		10,100L
per day fuel consumption	800L		721L
per day fuel per m2	0.233L		0.195L
Fuel consumption ratio	100%	-16.3%	83.7%

2) Test and research on Air heating boiler at National E hospital

Boiler: boiler 2.5T/H & 3.0T/H for Air heating by Hidakawa

Fuel: Heavy oil B

Boiler operation: 15.5h/day

Remarks: New beds and New patients had been increasing every year

	Fuel consumption		Comparison of 72 & 73		with PEAM	Comparison of 73 & 74	
	1972	1973	L	%	1974	L	%
June	18,915	20,807	+1,892	+10.0%	19,344	-1,463	-7.0%
July	20,385	21,751	+1,366	+6.7%	19,900	-1,851	-8.5%
August	21,730	22,919	+1,189	+5.5%	19,173	-3,746	-16.3%
September	19,587	19,768	+181	+0.9%	18,787	-981	-5.0%
October	22,305	24,746	+2,441	+10.9%	19,678	-5,068	-20.5%
November	31,047	32,326	+1,279	+4.1%	27,469	-4,857	-15.0%
Total	133,969	142,317	+8,348	Ave. +6.4%	124,351	-17,966	Ave. -12.1%

3) Test and research on 6.0T/H Boiler at T factory of N Ltd.

Boiler: 6.0T/H boiler
 Fuel: Heavy oil B
 PEAM was injected into 1.0KL fuel tank

120min observed testimony of Client

	Flame color	Inside of Furnace	Top flame edge	Combustion
Without	Red-Orange	Light haze, Darkish	Smooth round shape	Calm
30min w/ PEAM	Pink-Orange	Reducing haze from Top flame	Jaggy shape on top and Moving	Very hard
60-90min w/ PEAM	Yellow-Dark Yellow	Visible end of Furnace	Saw teeth shape, Moving up/down	Active, Volute flame edge
120min w/ PEAM	Bright Yellow	No haze, Vistaed sight	Shorting flame, ideal shape	Well combustion, color, shape

Evaporation coefficient ... producing water vapor (Kg) per Heavy oil (L)

Without		With PEAM	
9:00	12.30 Kg/L	12:00	12.57 Kg/L
10:00	12.66 Kg/L	13:00	12.86 Kg/L
11:00	12.26 Kg/L	14:00	13.08 Kg/L
Ave.	12.41 Kg/L	Ave.	12.84 Kg/L
	100%	+3.5	103.5%

4) Test and research on at Hostel facility

Boiler: Casting Iron made boiler for Air heating by Showa Manufacturing (6 years old)
 Rated heat generation amount: 385,700Kcal/h
 Rated heat transmission area: 21.5m²
 Fuel: Heavy oil B

	Without July 1972		With PEAM July 1973
Fuel consumption			
per day	82 L	-14.6%	70 L
per month	2,458 L	-13.3%	2,130 L

5) Test and research on large hot spring bath at Hotel A

Boiler: boiler for Water heating by Daiich

It is difficult to expect an exact comparison of the fuel consumption due to unfixed factors like number of bath customer, water temperature and water volume, etc.

July 1974 without						July 1975 with PEAM					
7th	Wed	110	19th	Mon	130	7th	Fri	120	19th	Wed	100
8th	Thu	120	20th	Tue	110	8th	Sat	120	20th	Thu	100
9th	Fri	110	21st	Wed	100	9th	Sun	close	21st	Fri	95
10th	Sat	120	22nd	Thu	100	10th	Mon	130	22nd	Sat	100
11th	Sun	close	23rd	Fri	140	11th	Tue	90	23rd	Sun	close
12th	Mon	130	24th	Sat	120	12th	Wed	100	24th	Mon	125
13th	Tue	115	25th	Sun	close	13th	Thu	100	25th	Tue	90
14th	Wed	110	26th	Mon	125	14th	Fri	100	26th	Wed	110
15th	Thu	115	27th	Tue	100	15th	Sat	105	27th	Thu	90
16th	Fri	120	28th	Wed	125	16th	Sun	close	28th	Fri	90
17th	Sat	110	29th	Thu	100	17th	Mon	100	29th	Sat	105
18th	Sun	close	30th	Fri	105	18th	Tue	105	30th	Sun	close
			21 days	2,415					20 days	2,075	
			Ave.	115.0					Ave.	103.8	
			Comparison	100%					-9.8%	90.2%	

Testimonies of the owner

- i. The fuel saving ratio was 9.8%, but the customers had been increasing in 1975 comparing to a year before in 1974.
- ii. After 1 month of using PEAM, a manual pump, Main tank to Service tank, obviously became lighter.
- iii. The soot might have been increased slightly, but the color of the soot had been changing to light brown, assuming by sludge dissolution. Probably further 3-5% fuel saving would be shown when the dissolution process to be completed.

6) Test and research on large hot spring bath at Hotel B

Boiler: Stainless made boiler for Water heating

Fuel: Heavy oil B

1/2 PEAM dosage as 1/20000

June 24th to July 23rd in 1974						June 24th to July 23rd in 1975 with PEAM					
Date	Water	Fuel	Date	Water	Fuel	Date	Water	Fuel	Date	Water	Fuel
24-Jun	30.1	70.8	9-Jul	59.0	138.7	24-Jun	55.3	113.4	9-Jul	59.3	121.7
25-Jun	44.0	103.3	10-Jul	46.5	109.2	25-Jun	47.6	97.8	10-Jul	52.2	107.2
26-Jun	close	close	11-Jul	51.5	121.0	26-Jun	54.9	112.6	11-Jul	close	close
27-Jun	51.5	121.0	12-Jul	45.2	106.0	27-Jun	close	close	12-Jul	59.4	122.0
28-Jun	37.7	88.5	13-Jul	42.7	100.3	28-Jun	55.6	114.0	13-Jul	62.1	127.4
29-Jun	36.4	85.6	14-Jul	42.7	100.3	29-Jun	67.8	139.1	14-Jul	42.4	86.9
30-Jun	44.0	103.3	15-Jul	44.0	103.3	30-Jun	30.0	61.6	15-Jul	55.6	114.0
1-Jul	45.2	106.2	16-Jul	close	close	1-Jul	43.6	89.5	16-Jul	39.0	80.1
2-Jul	45.2	106.2	17-Jul	67.9	159.3	2-Jul	42.6	87.5	17-Jul	54.6	112.0
3-Jul	37.7	88.5	18-Jul	42.7	100.3	3-Jul	65.0	133.4	18-Jul	close	close
4-Jul	49.0	115.1	19-Jul	45.2	106.2	4-Jul	close	close	19-Jul	62.2	127.7
5-Jul	44.0	103.3	20-Jul	45.2	106.2	5-Jul	61.0	125.1	20-Jul	55.6	114.0
6-Jul	close	close	21-Jul	47.7	112.1	6-Jul	62.5	128.3	21-Jul	40.4	82.0
7-Jul	70.4	165.2	22-Jul	39.0	91.5	7-Jul	52.5	107.7	22-Jul	55.0	112.9
8-Jul	49.0	115.1	23-Jul	51.5	121.0	8-Jul	63.8	130.8	23-Jul	48.6	99.8
			27 days	1,255.0	2,947.5				26 days	1,388.6	2,848.5
			Water / Fuel		0.426/L				Water / Fuel		0.487/L
			Comparison		100%				+14.5%		114.5%

Testimonies of the owner

- i. After 10 days of using PEAM, the color of flame had changed from Reddish to Whitish color. Also, Yellowish soot with sulfur had adhered on inside of the boiler, and the soot had started easily to shed off only by heat pressure of the fuel. (The shedding soot process had started on this stainless made boiler much earlier than steel made boilers.)
- ii. After 1 month using PEAM, a periodical cleaning of the duct pipe was very much easier than before; all adhering soot came off easily by only pushing a wire brush into the pipe.

Customer Testimonies

(a) Red Cross Japan H hospital

This hospital was awarded a top prize at National energy saving competition on Boiler efficiency (Oil consumption per Bed)

Boiler: Gun type boiler 3.0T/H for Air heating by Tokai
Fuel: Heavy oil A

- ✓ Improvements on Clogging of Tip
- ✓ Reducing Unburnt carbon at Nozzle area and inside of Furnace
- ✓ No deposit at Tube
- ✓ Oil reduction was 3.3%

(b) National I hospital

Boiler: Through flow boiler 3.0T/H for Air heating
Fuel: Heavy oil C

- ✓ The easiest handling additives, simply adding 1/10000 PEAM into Fuel tank
 - ✓ The flame color during combustion became very bright and good color
 - ✓ Reducing adhesion like Unburnt carbon on Burner tip
 - ✓ Improvements on Sludge dissolution and very easy periodical Strainer cleaning
- * Improvements on flame color shall be caused by temperature increase
(efficiency improvements)

(c) National Institute

Boiler: Takasago-400 on/off type boiler 0.5H/H for Air heating by Takasago Industry
Fuel: Heavy oil A

Rated evaporation coefficient amount: 497Kg/H
Rated heat transmission area: 15.7m²
Steam condensate return water: 0.63KL (full), 0.48KL (average)

- ✓ 5% of fuel saving result was confirmed by simply adding 1/10000 PEAM.
- ✓ Assuming approx 10-12% of fuel saving by narrowing Nozzle.

(d) Monitoring test of household

Boiler: Gun type burner Through flow boiler for Water heating

Fuel: Heavy oil B (30-35L/day)

- Injected 30cc of PEAM into the 300 litter fuel service tank in the morning
- The same day of the evening realized improvements on the flame and eliminated odor of sulfurous acid gas at the inspection window.
- A week later, checked the drain valve of the fuel service tank, which did not clean for 1.5 years, then noticed sludge became as slimy gel and through. The moisture was totally separated. The work of removing sludge used to be a very hard work, indeed.
- After 2 month of using PEAM, confirmed at least 10% of fuel saving. Unburnt carbon and Slug were disappeared from the inside of Boiler and Water pipe.
- After 4 month of using PEAM, confirming approx 20% of fuel saving comparing to the same month of a year before. The most surprised thing was disappearing sludge in the 2000 litter underground fuel storage tank, which was checked carefully by an inspection gage stick many times.
- Currently, no miss-ignition, almost no cleaning like oil strainer.

(f) Monitoring test of K hot spring bath

PEAM dosage of 1/10000 into the main fuel tank

Without PEAM, fuel consumption was 2KL in every 12-13 days ... $2000 / 13 = 153.8\text{L/day}$

With PEAM, fuel consumption was 2KL in every 15-16 days ... $2000 / 15 = 133.3\text{L/day}$

Approx fuel saving ... $(153.8 - 133.3) \times 100 / 153.8 = 13.3\%$

- The first 2 weeks of using PEAM, Ssoot had increased much, but Soot had completely gone in 6 weeks.
- The main fuel tank located on the top of the building, and it seems to be less sludge deposit. Generally, underground fuel storage tank had more sludge deposit.

(g) Monitoring test of KS hot spring bath

PEAM dosage of 1/10000 into the main fuel tank

- Main fuel tank and Service tank had much sludge deposit. (Heavy oil did not come out when open the drain cock of the service tank was opened. It took about 15 minutes to come out a drop of Heavy oil by pushing a stick into the tank.
- Before using PEAM, it was necessary at least 1 time or more of cleaning of Heavy oil filter in a month due to clogging problems, but since using PEAM, there was no strainer clogging even no cleaning over a month.