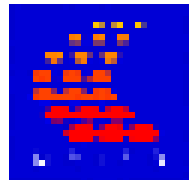


# Experiences and research experiments of boilover test in Japan

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# Introduction

- Considering size of Japanese economy, total amount of oil use in Japan, we have not experienced so much oil tank fires, boilover.

In the past about 60 years, about 200 fires in oil storage tanks, and about 30 large oil tank fires, and 2 boilovers. These numbers are not big.

- However, we did many oil tank fire research, including large oil burn tests(up to 80 m pan), boilover tests(up to 5 m pan).
- We are doing biodiesel research, and found it makes boilover.
- Here, we introduce our experiences(accidents and research) in regard to boilover.

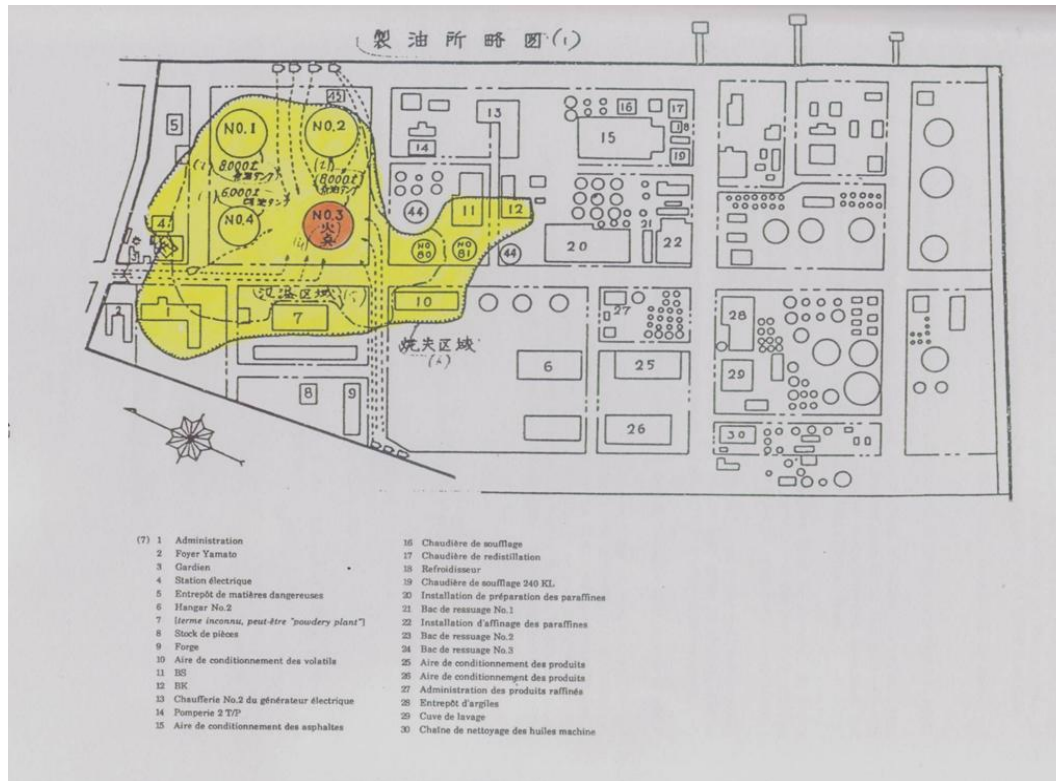
# Two experiences of boilover in Japan

	Yokaichi, Mie	Nigata
Year	Oct. 15, 1954	June 16, 1964
Fuel	Fuel oil	Crude oil
Cause	Not clear. A fuel oil C tank ignited suddenly.	Earthquake Magnitude 7.7
Summary	Fuel oil C tank boil-overed, 6 hours and 45 min. after ignited. There was not bund around tanks.	30,000 kL tank ignited, then spread to other four tanks. Tanks in another area ignited. 3 days after fire started, boilover occurred.

# Boilover accident, Yokaichi, Japan

- October 13, 1954
- Daikyo-oil Co, Yokaichi, Japan
- Suddenly, Fuel-C oil storage tank ignited, and continued several hours. Then boilover occurred.
- 13 people were injured.
- Totally 6 oil tanks destroyed, and buildings were burnt.
- Because of no dike (Bund), heated oil from the tank spread over and made fire fighting people injured.

# Yokaichi, Mie, Japan



No. 3 tank; diameter: 32m, height: 11m, Volume: 8000 ton, 7000 ton fuel C existed in the tank. There is no dike. Unfortunately, no picture is found.

# Yokaichi, Mie, Japan

- 11:30 AM, Oct. 15, No.3 Fuel oil C ignited with large sounds, suddenly. Flame appeared between roof and tank shell. **No. 3 tank; diameter:32m, height: 11m, Volume 8000 ton, 7000 ton fuel existed in.**
- 1:00 PM, Roof sunk completely. Open full fire.
- 6:00 PM, Oil spread over from No.3 tank.
- 7:30 PM No.4 tank ignited.
- 8:00 PM No.1 tank ignited
- 7:30 PM, Oct. 16, fires were extinguished.

# Boilover, Nigata, Japan

- June 16, 1964
- Crude oil
- Syowa-shell, Nigata, Japan
- By large earthquake, oil refinery was damaged. And then large oil tank fires started. After several hours, boilover occurred in a crude oil storage tank.
- Totally about 50 tanks were burnt, and fires continued for about 4 days.



# Nigata earthquake (June 1964)



## Summary of large boilover tests in Tomakomai, Japan

	Test # 1	Test # 2
Pan	D=5m, H=0.9m	D=5m, H=0.9m
Burning oil	2.4 kL	2.5 kL
Depth and temperature of isothermal layer when boilover start	331mm, 282 C	328mm, 290 C
Time to boilover	78.8 min	66.4 min
Intensity of boilover*	5.8, 22.0	4.6, 22.7
Fuel layer regression rate	0.096 m/hr	0.12 m/hr
Hot zone regression rate	0.34 m/hr	0.40 m/hr

\*; Based on radiation data, Peak radiation/ steady burns radiation

# Tomakomai large tank fire tests

We had two large fire tests using crude oil, in Tomakomai, Japan.



Boilover test D=5m, Arabian  
Crude oil, Feb. 1999



20m tank fire  
Jan. 1998

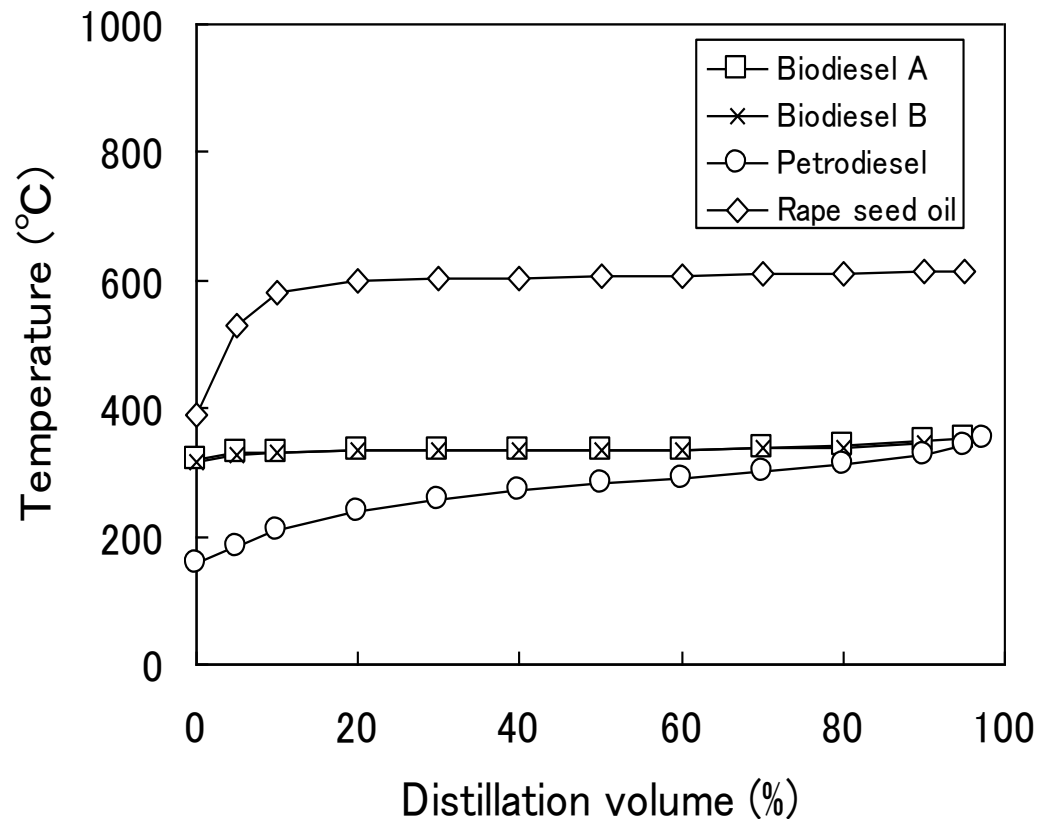
Details are reported in [Fire Safety Journal](#) 41 pp.529-535  
(2006)

# Results of the research

- Lee-wind side is more dangerous because of strong radiation when boilover occurred.
- Hot zone regression rates were obtained, **0.34 m/hr and 0.40 m/hr**. These numbers are reasonable, but they may be some small ones, compared with information of boilover in real tank fires. These numbers are very important to estimate when boilover occurs.
- Fire-fighting may accelerate boilover, because of stirring oil and water.

# Biodiesel research

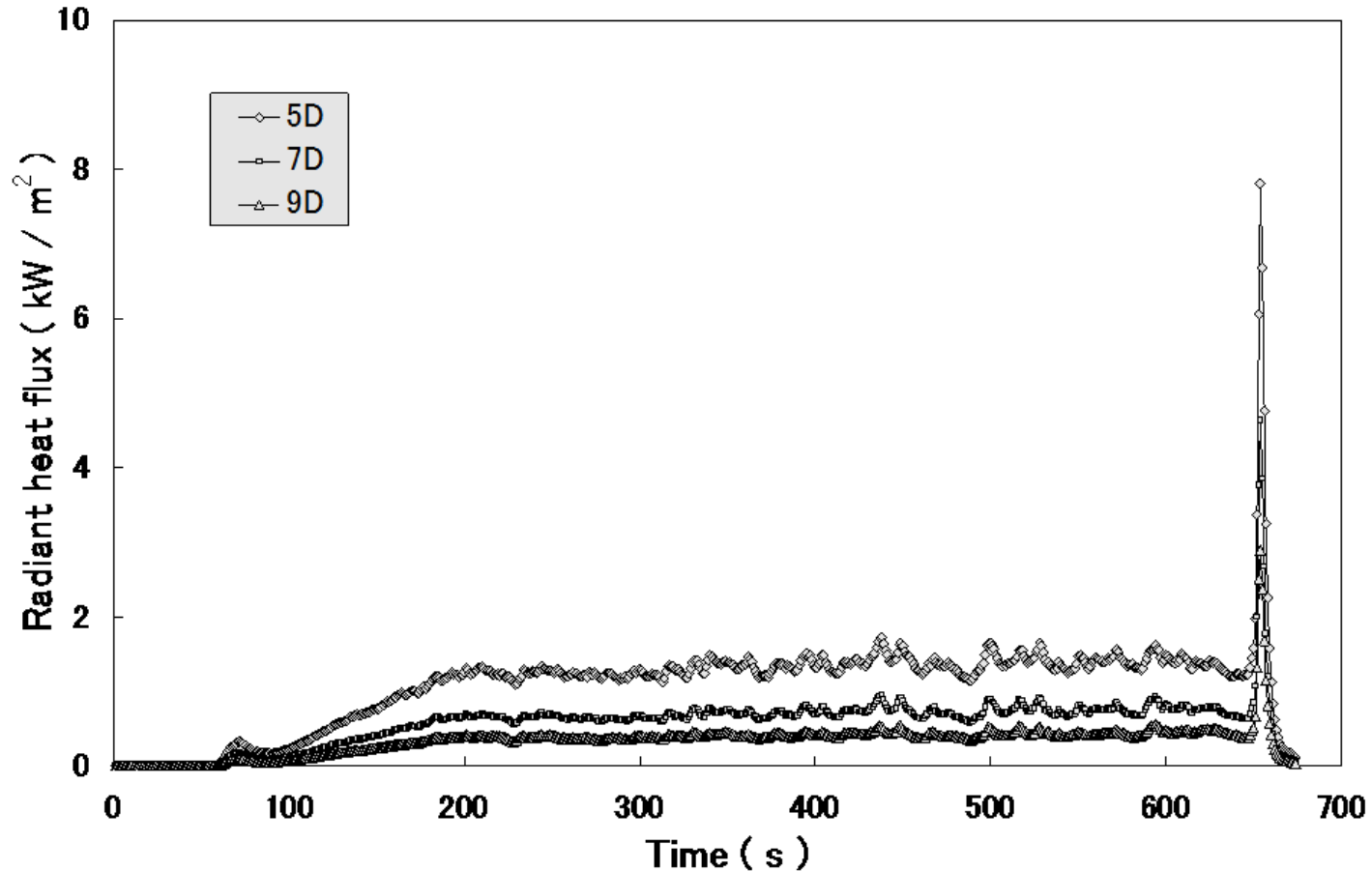
According to distillation curves, Biodiesel is so uniform, but makes boilover after long burning



# Biodiesel burn tests, NRIFD Indoor test facilities



# Boilover of Biodiesel (BDF)



Time history of radiant emittance in biodiesel burning (Pan diameter; 0.92m, Fuel and water thickness; 0.10 m)

## Comparison of burning rate and radiation at steady state burning

	Burning rate (mm/min)	Radiation (kW/m <sup>2</sup> )*
Biodiesel	1.55	1.3~1.5
Diesel oil	2.5~3	1.6~2
Gasoline	4.5	2.2~2.7
Kerosene	3.4	1.88
Rape seed oil	1.2	1.2~1.8

\*: Measured at L/D=5 from the center of the pan



# Conclusions

- Boilover accidents in Japan are introduced. Fortunately we have not experienced for last 45 years, even we had large oil tank fires.
- Even we have not experience so often, we did large boilover tests.
- Biodiesel makes boilover, but we do not know its mechanism.
- Thank you for attention. If you have any question, please contact me; [koseki@fri.go.jp](mailto:koseki@fri.go.jp)