

# ASBC Annual Meeting

June 4–7 ■ Fort Myers, Florida

*See what SCIENCE can brew for you*

## Monitoring and control of onion-like off-flavor component precursor in large-scale brewing

The Asahi logo, featuring the word 'Asahi' in a stylized, blue, italicized font.

Taku Irie, Shigekuni Noba and  
Minoru Kobayashi

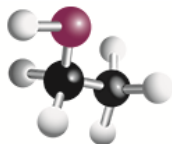
Asahi Breweries, Ltd.

- Background
- Purpose of this Study
- Materials and Methods
- Results and Discussion
- Summary

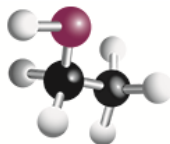
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## Our results on the technological development for the control of sulfur off-flavor components in beer

- Analysis of volatile thiols in beer with on-fiber derivatization and GC/MS determination, M. Kobayashi, WBC 2012
- Factors affecting the formation of dimethyltrisulfide in beer, N. Doi, WBC 2013
- Mechanism of dimethyl trisulfide formation in stored beer, N. Doi, ASBC 2014
- Identification of a precursor of 2-mercapto-3-methyl-1-butanol in beer, S. Noba, WBC 2016
- Elucidation of the formation mechanism of 2-mercapto-3-methyl-butanol (2M3MB) in beer, S. Noba, EBC 2017
- Heterogeneous fermentation method in multi-filling cylindroconical vessels for high quality beer, Y. Nakamura, WBC 2012
- The equipment to sample the fermenting beer from four positions in the cylindroconical vessel and its practical application to flavor improvement in the brewery, H. Koizumi, WBC 2012
- Analysis of sugar attenuation with a curve-fitting method and its application for industrial fermentation control, T. Irie, ASBC 2015
- Monitoring of an onion-like off-flavor component and its precursor in large-scale brewing, T. Irie, EBC 2017



For us, technologies to control sulfur off-flavor components are...



For us, technologies to control sulfur off-flavor components are...

- Necessary to brew low-malt beer (Happoshu, New genre Beer) with low nutrients (amino acids, etc.) in the wort.

## Beer

Malt : 67% and above



## Happousyu

Malt Below 25%

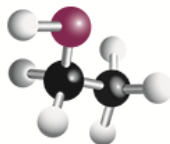
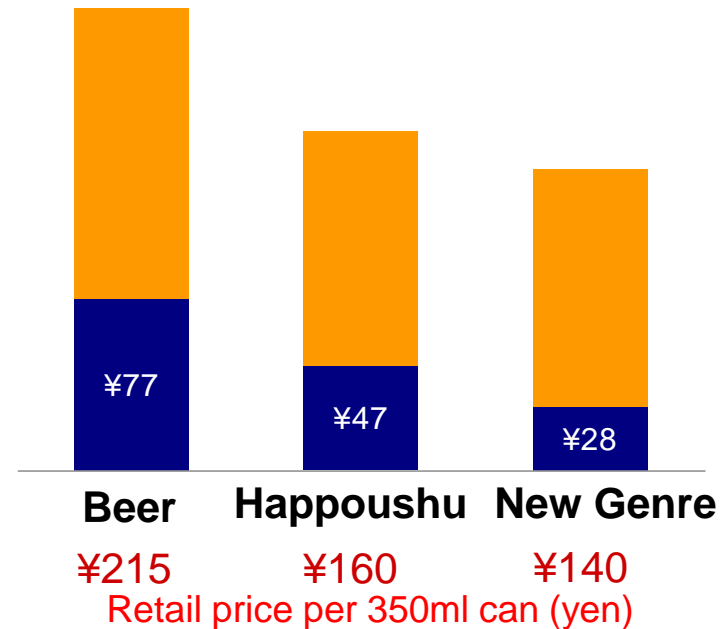


## New Genre

Malt 0%  
or Liquor type (Happoshu + spirits)



## ■ Liquor taxes and shop prices



For us, technologies to control sulfur off-flavor components are...

- Important to increase “clearness,” “smoothness” and “freshness” of products, as these qualities are preferred by Japanese consumers.

Sophisticated clear  
taste



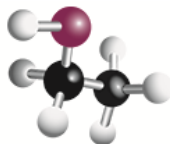
Inexperienced  
“KIRE”

洗練された  
クリアな味、辛口。

**SUPER  
“DRY”**

**キレ : KIRE**

Smoothness, Crispness, Cleanness,  
Refreshing



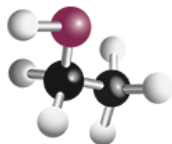
## Our results about controlling sulfur components

### Analytical technology in our R & D center

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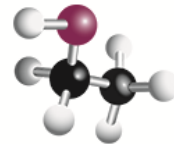
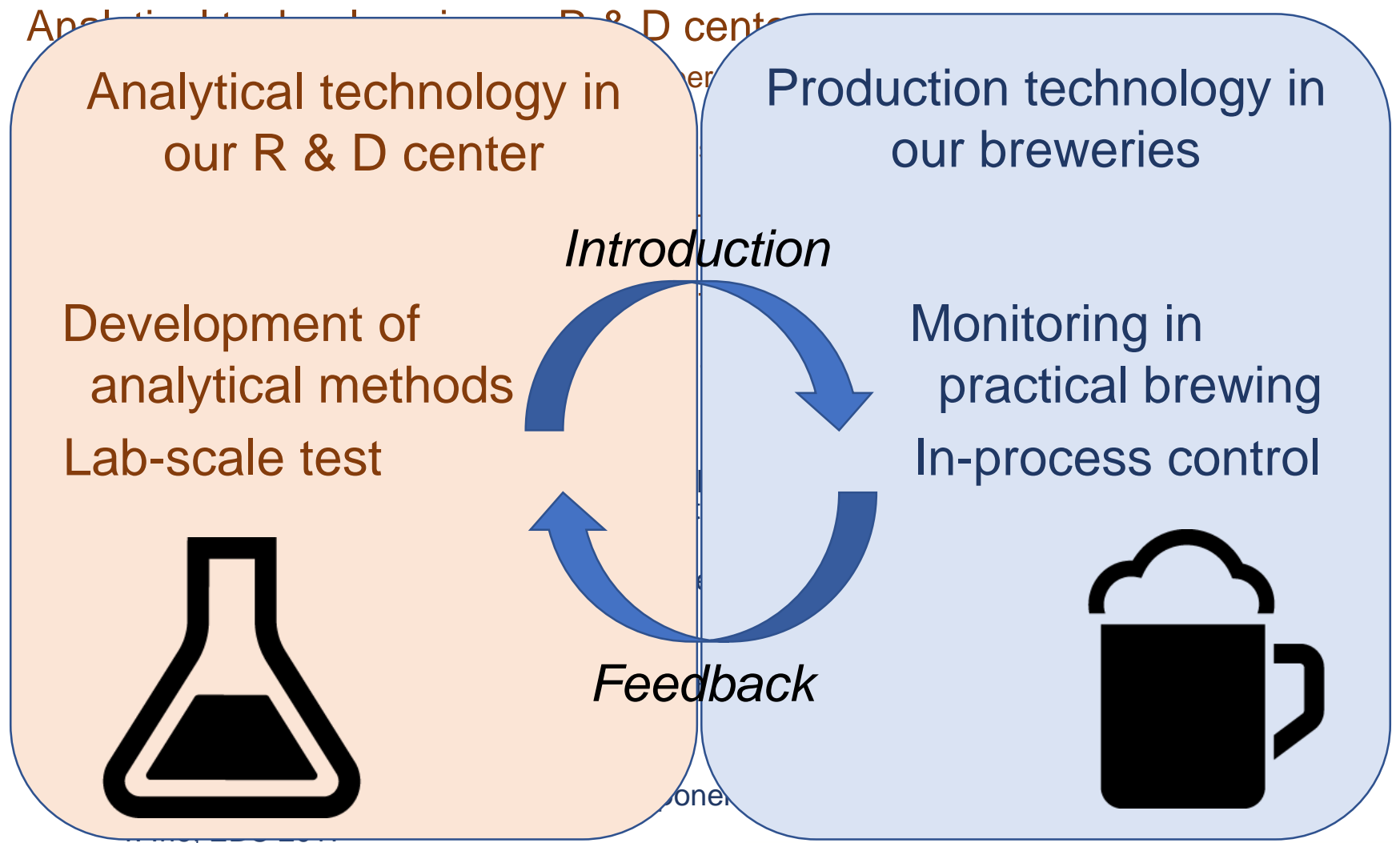
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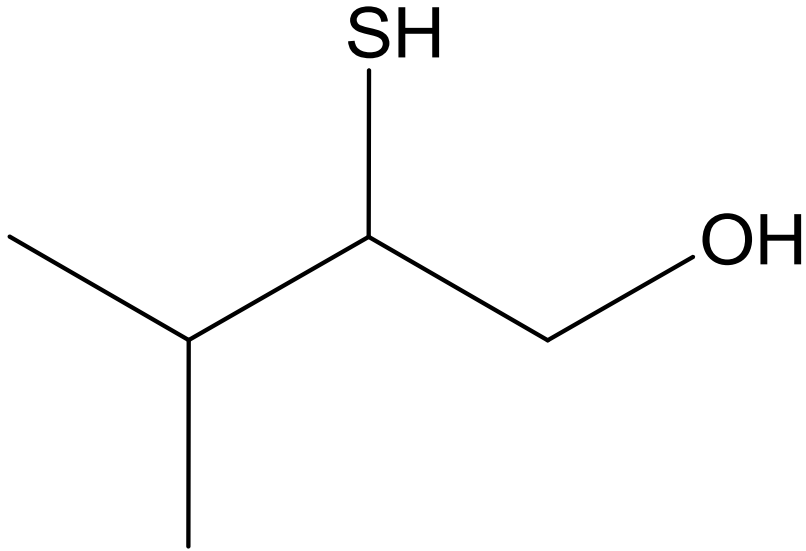




## Our results about controlling sulfur components



## 2-mercapto-3-methyl-1-butanol



### Odor

Onion, Sweat

### Threshold

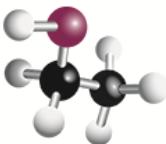
0.13 ppb

### Origin

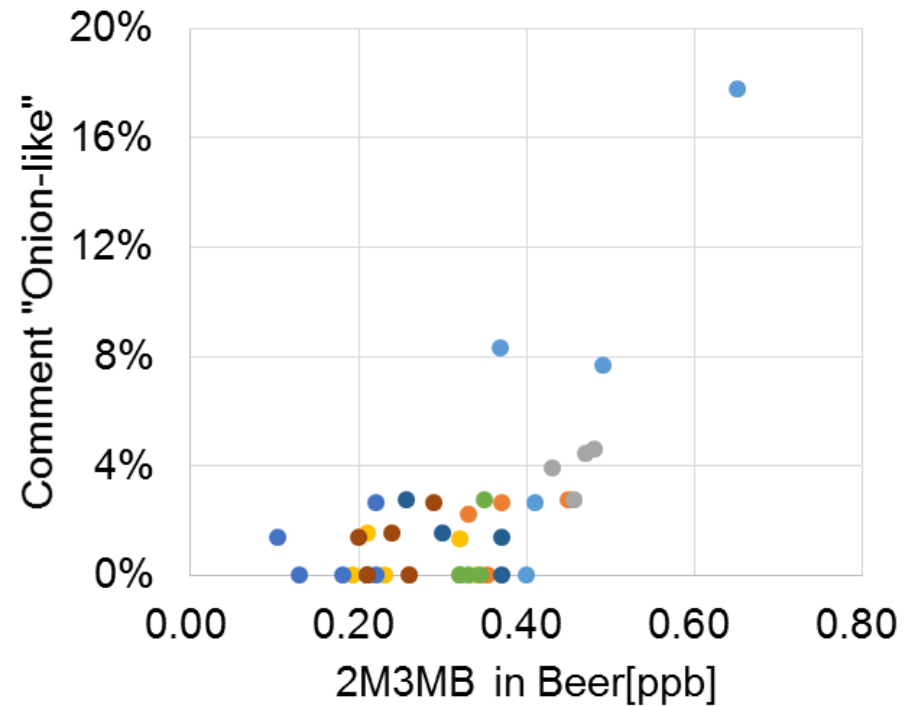
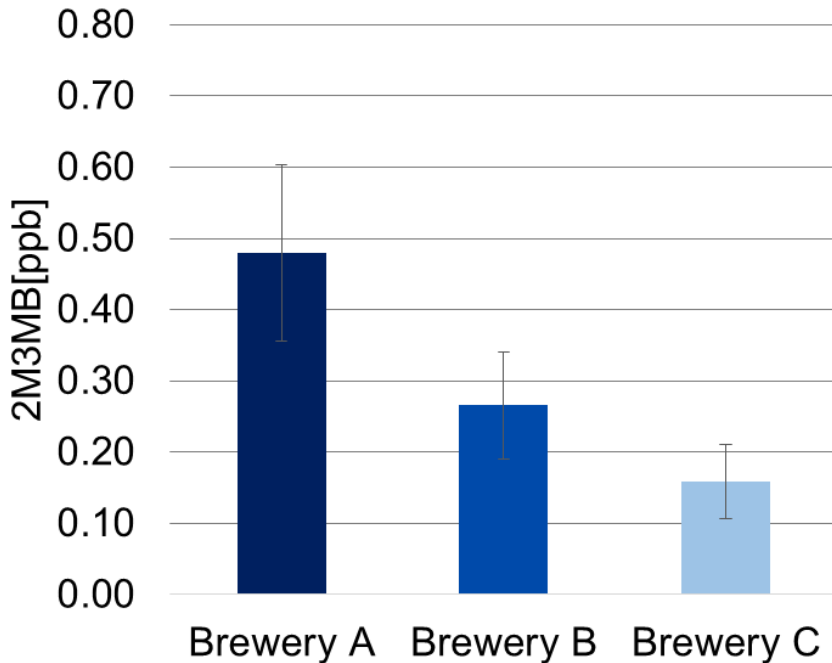
Hops



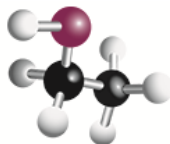
Source: Demand Media



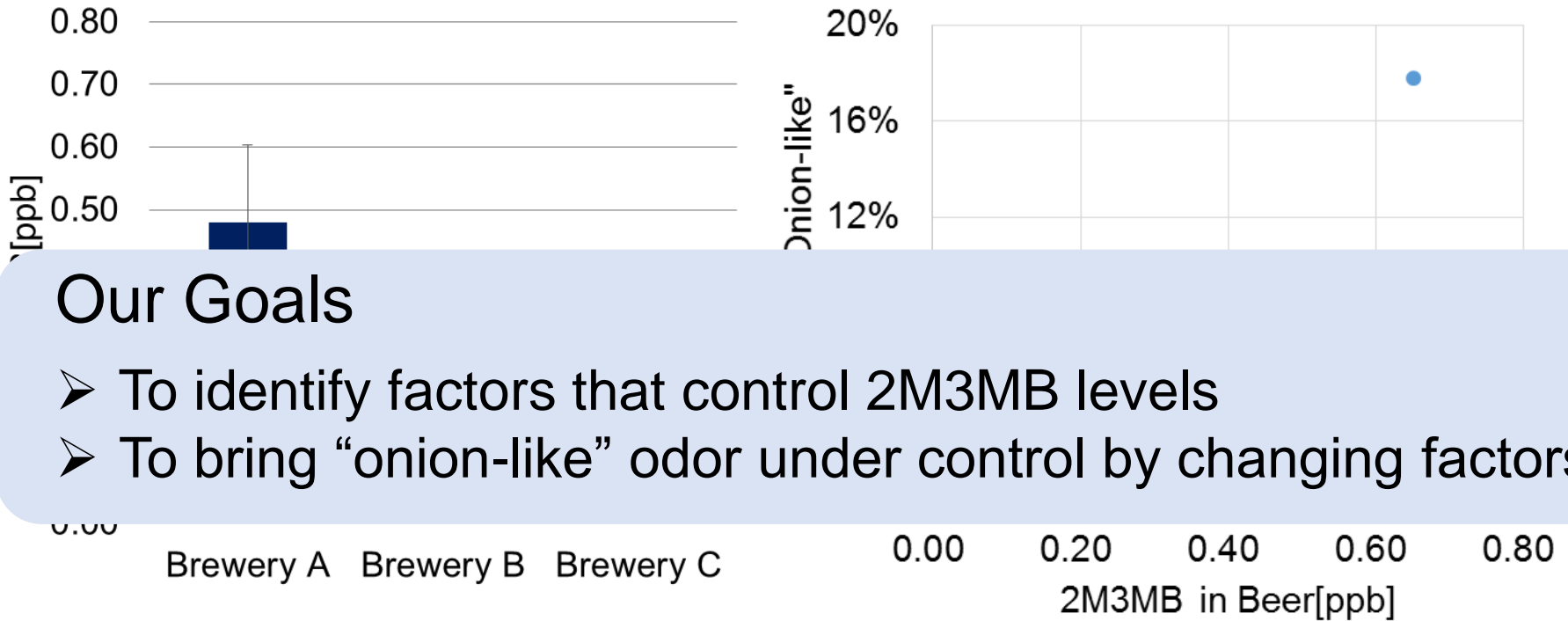
## 2M3MB in beer and “onion-like” odor in sensory test



- 2M3MB levels in beer differed among breweries.
- Comment “onion-like” increased above 0.40 ppb.



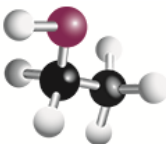
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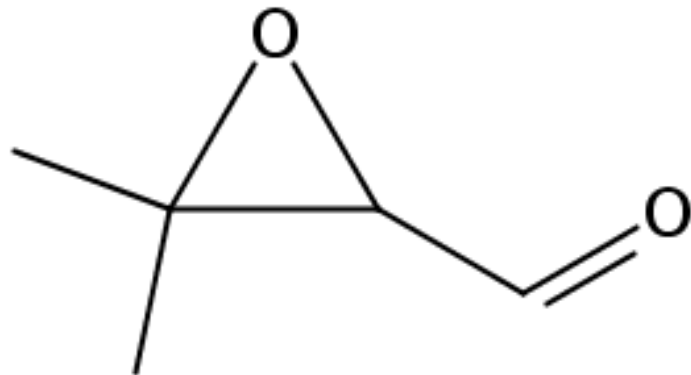


### Our Goals

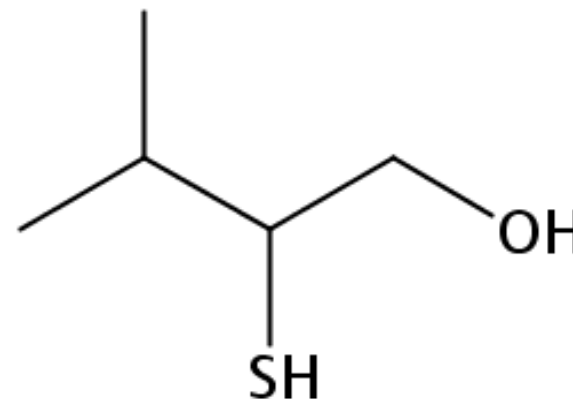
- To identify factors that control 2M3MB levels
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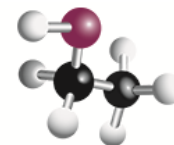
2,3-epoxy-3-methylbutanal  
(EMB)



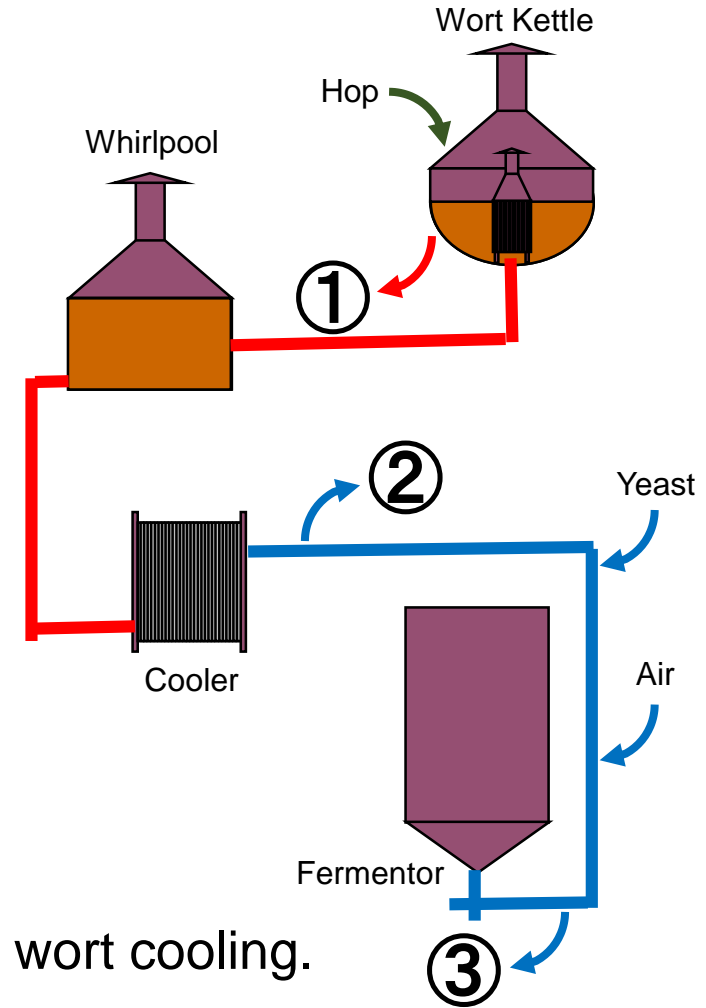
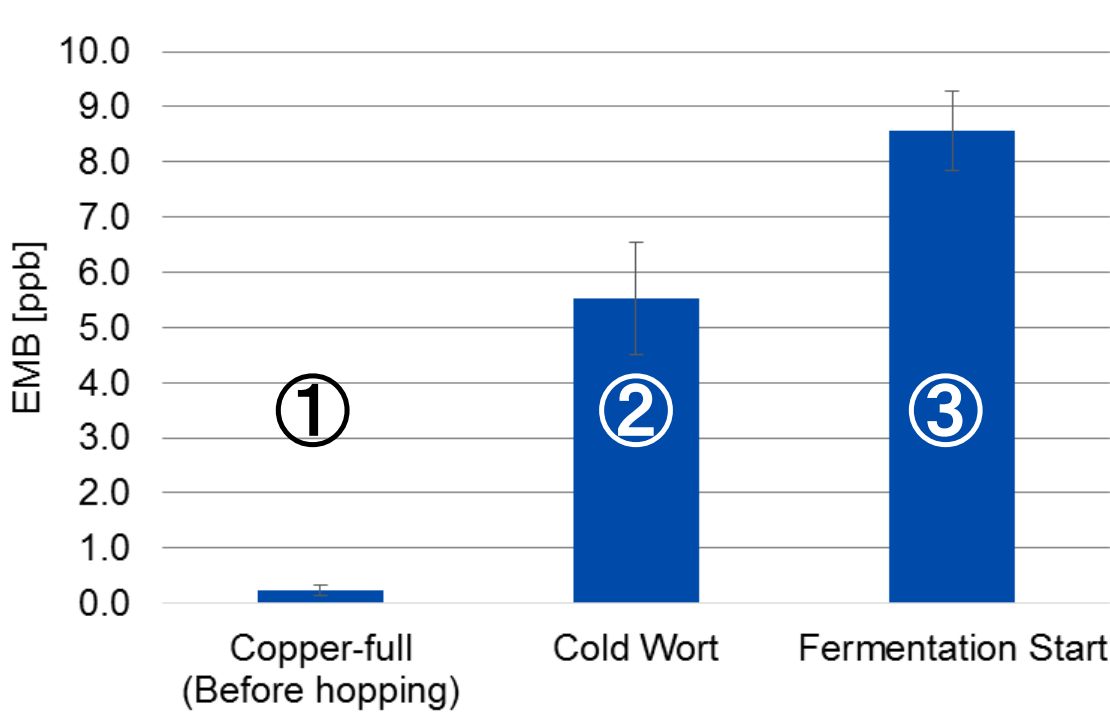
2M3MB

(Noba, WBC 2016)

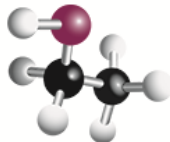
- The precursor of 2M3MB was purified from isomerized hops and identified as 2,3-epoxy-3-methylbutanal (EMB).
- The discovery of the precursor in food was first reported in 2016.



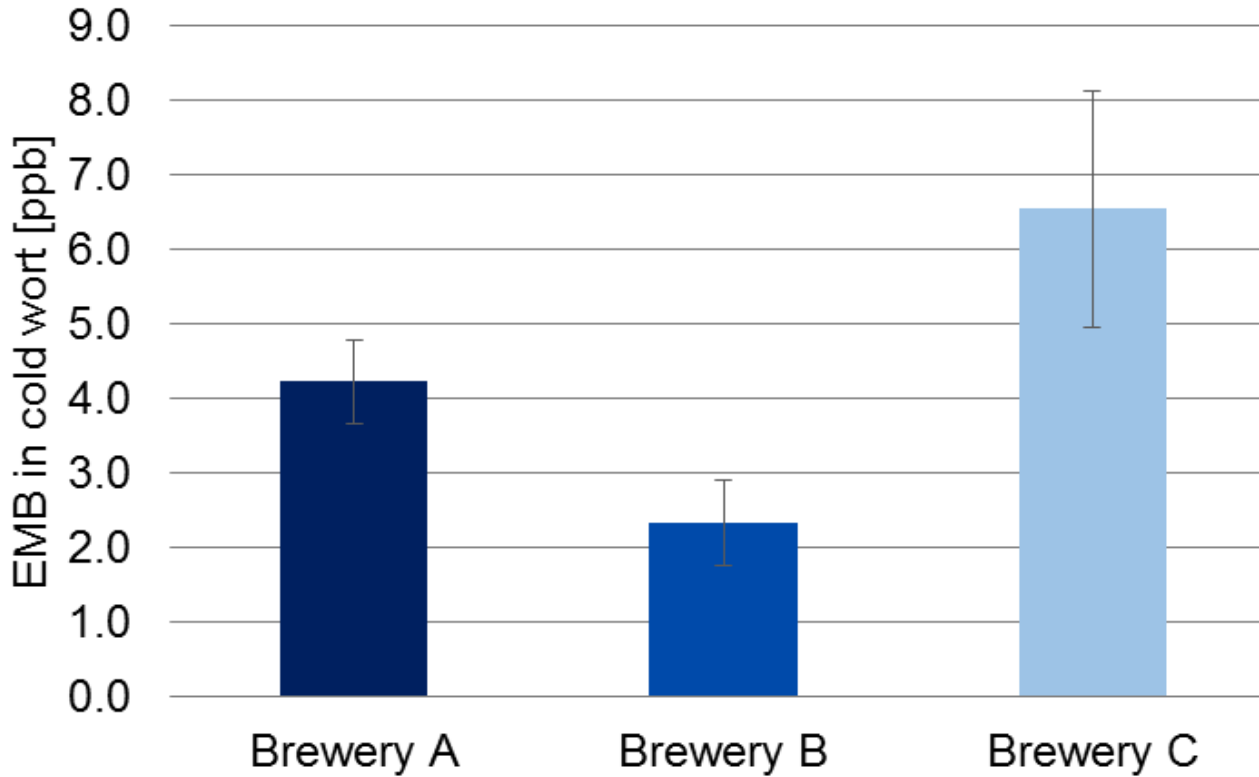
# Increase of the precursor in the brewhouse



- EMB was formed after hopping.
- EMB level increased both before and after wort cooling.  
: “Hot aeration” and “Cold aeration”

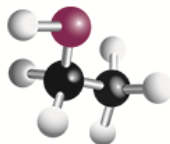


# Precursor of 2M3MB in cold wort



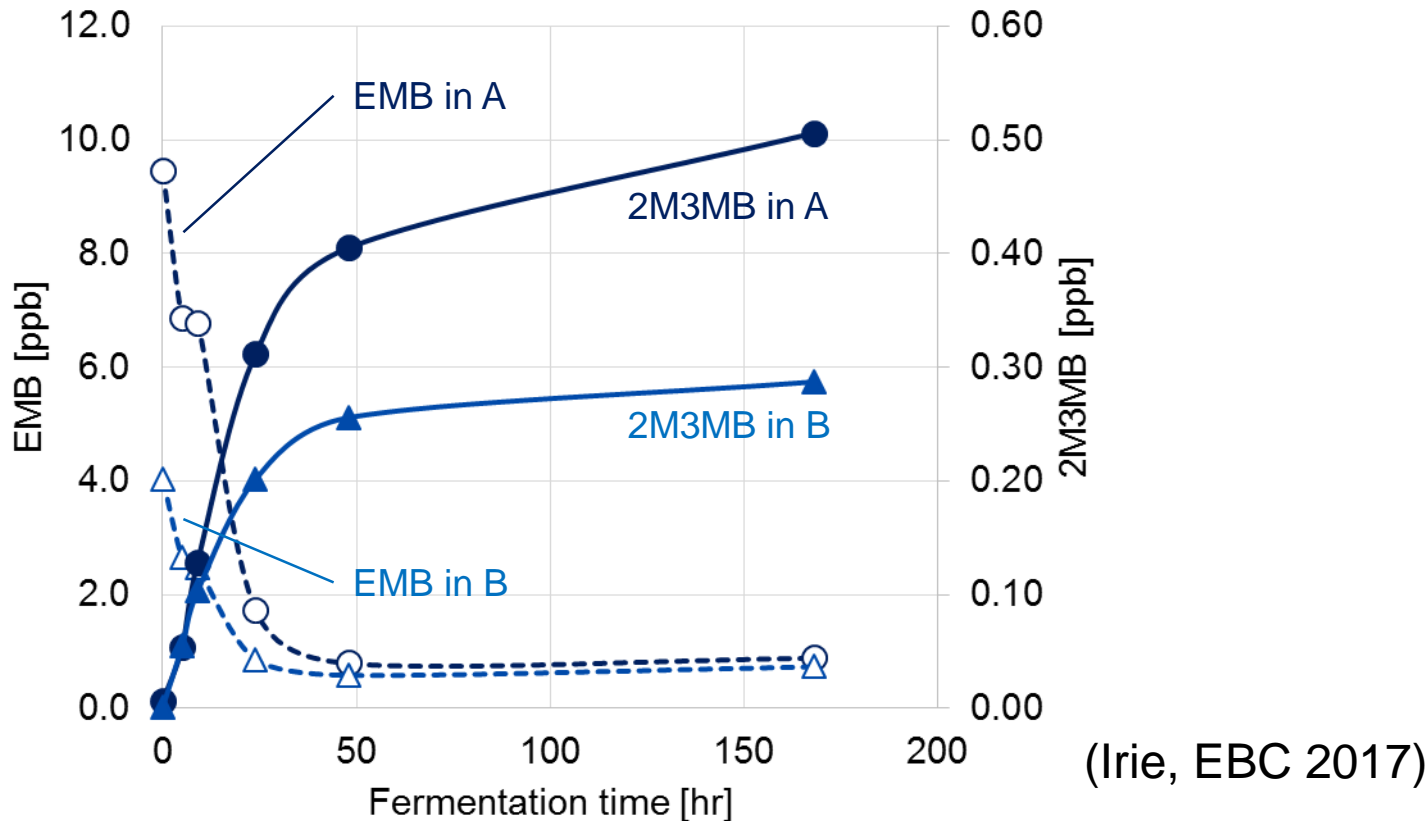
(Irie, EBC 2017)

- EMB levels in cold wort also differed among breweries.

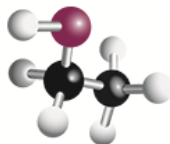


# 2M3MB and its precursor in Fermentation

## Brewery A vs Brewery B



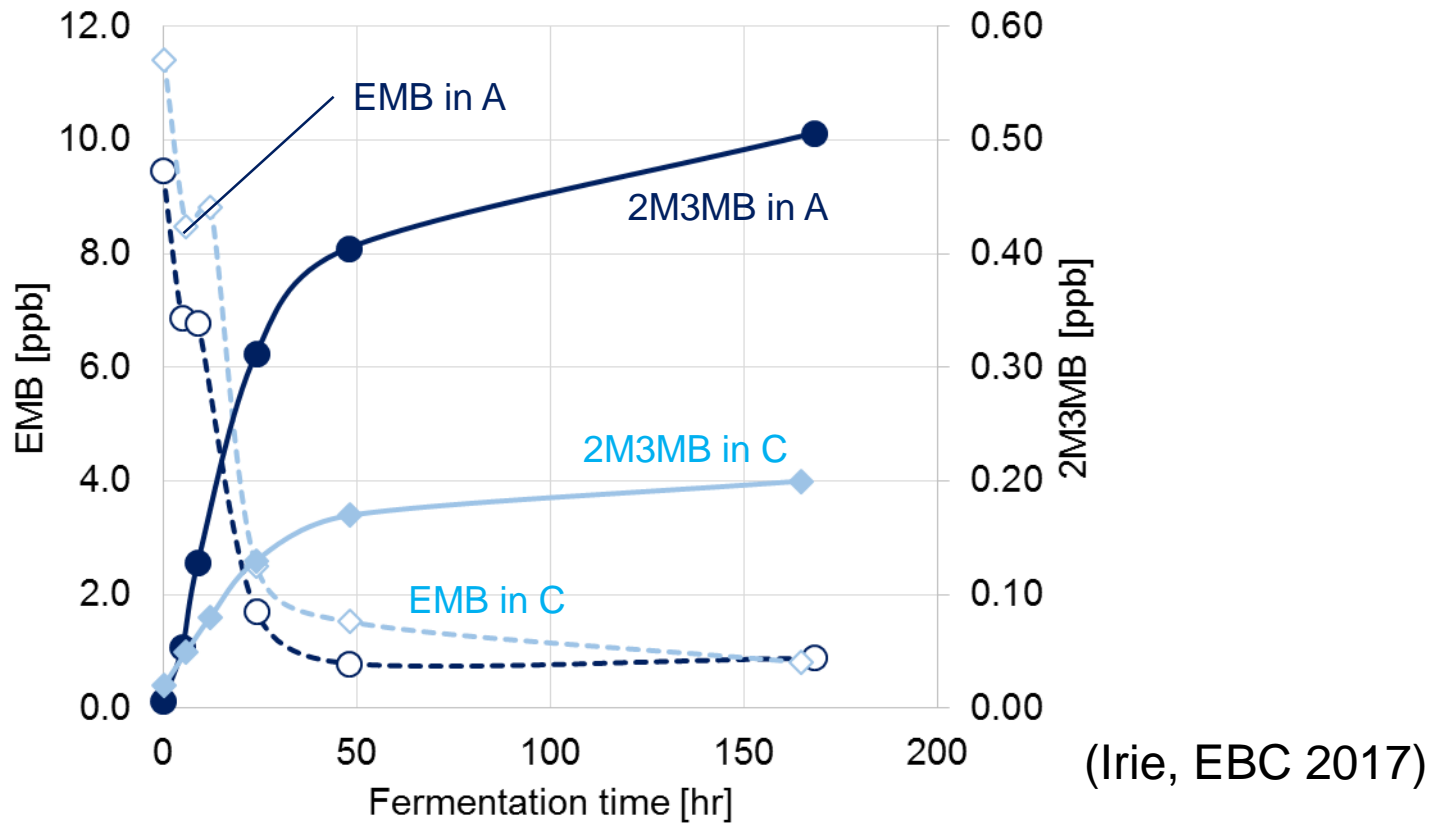
- EMB levels decreased immediately, concomitant with the accumulation of 2M3MB.
- The difference in 2M3MB levels between Brewery A and B seemed to reflect the EMB levels at the start of fermentation.



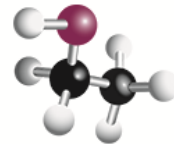


# 2M3MB and its precursor in Fermentation

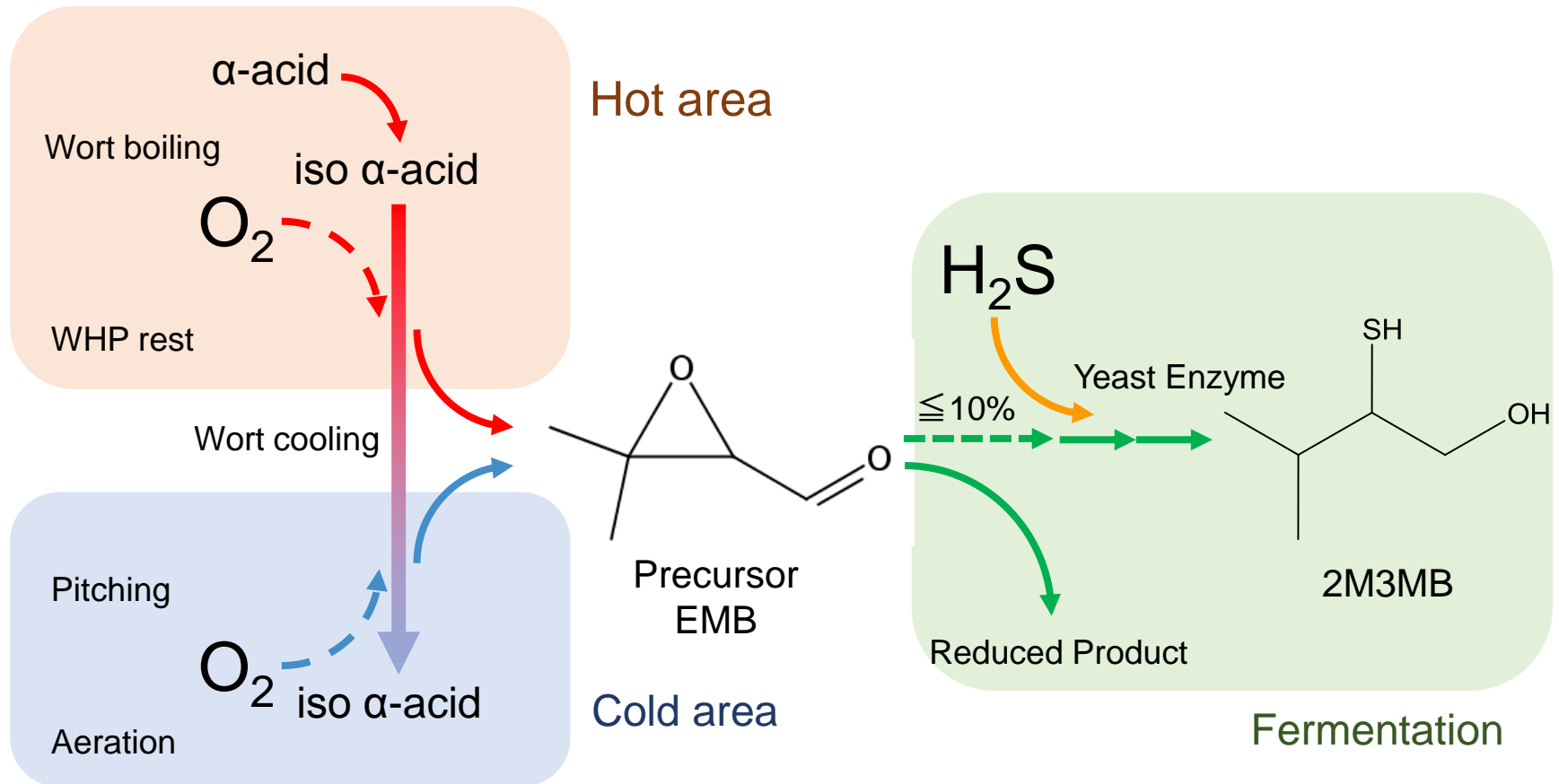
## Brewery A vs Brewery C



- Brewery C with high precursor levels showed a low conversion ratio to 2M3MB.
- The conversion ratio also differed among breweries.



# Proposed mechanism of formation of 2M3MB

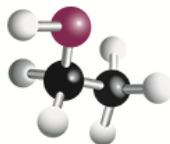


## 1. Formation of precursor

- Converted from iso  $\alpha$ -acid in hops
- Requires oxygen
- Occurs in both hot and cold areas

## 2. Conversion to 2M3MB

- Requires  $H_2S$  (Noba, EBC2017)
- Mediated by yeast; specific mechanism remains unclear.



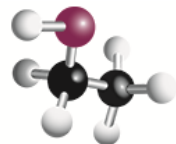
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## Our Goals

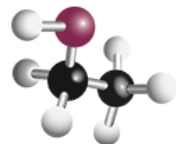
- To identify factors that control 2M3MB levels
- To bring “onion-like” odor under control by changing factors

## The topic of this presentation

- Further monitoring of the precursor (EMB) in the brewhouse, in the practical brewing process
- Investigation of the difference in the formation of the precursor at two breweries with differences in 2M3MB formation

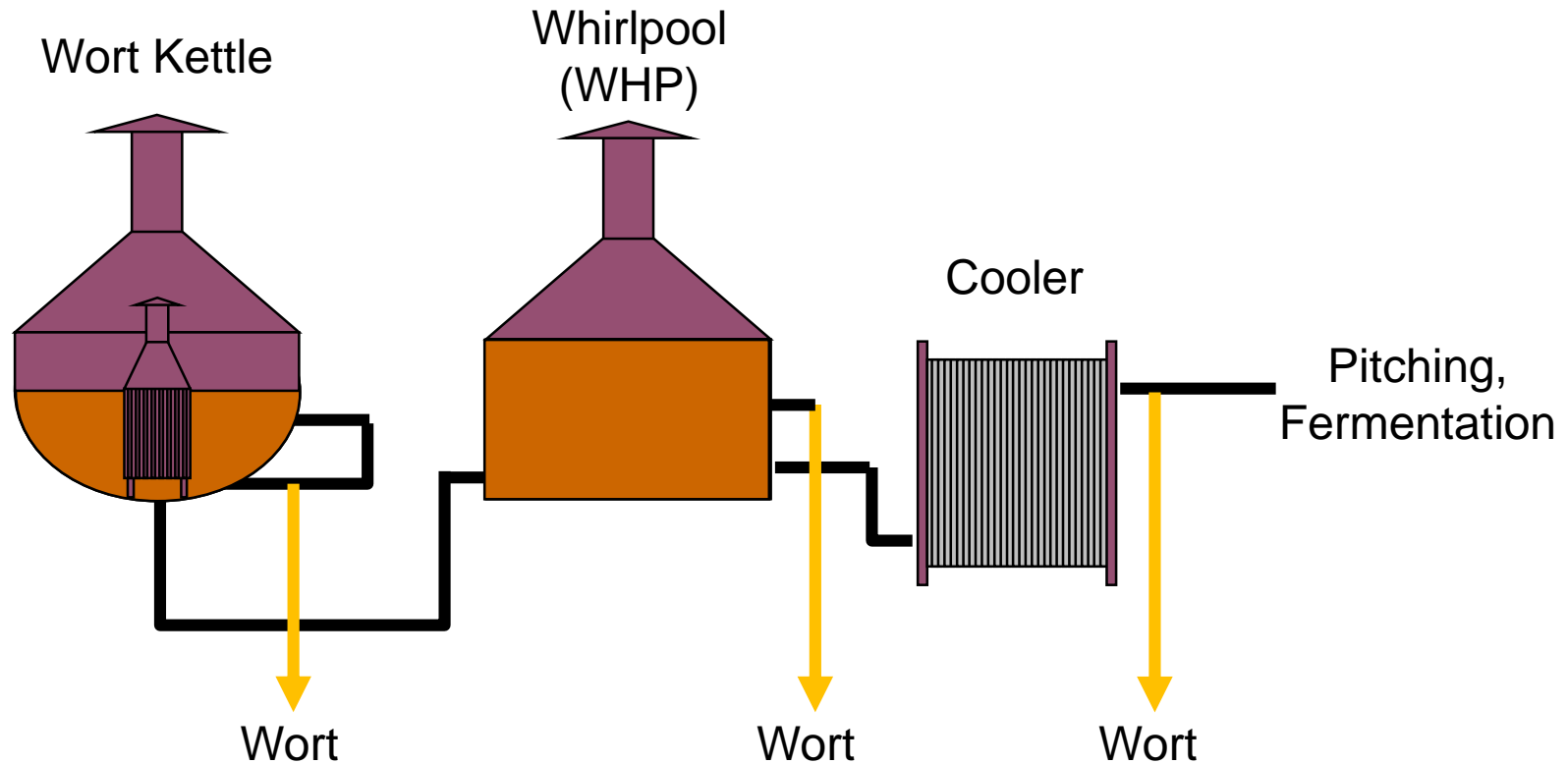


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## Monitoring levels of the precursor of 2M3MB in the brewhouse

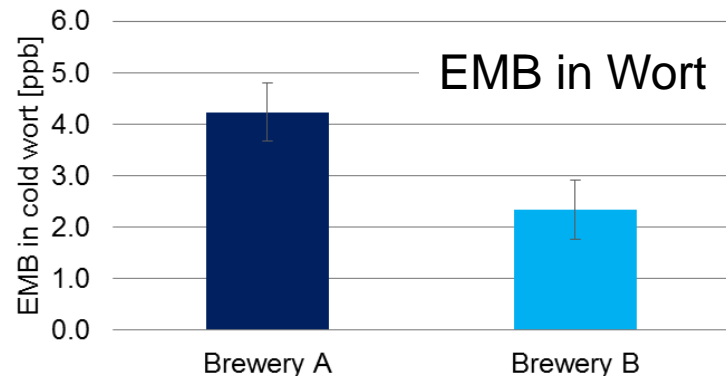
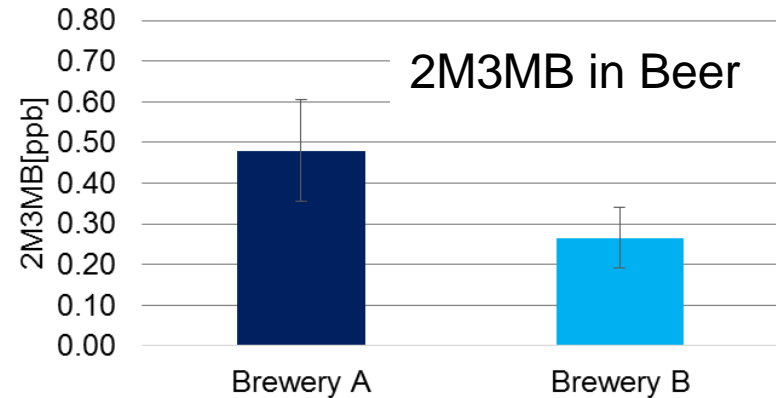
- from wort kettle, whirlpool and wort cooler
- from the start of boiling to wort cooling



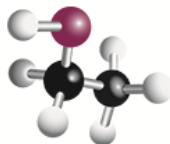
## Monitoring levels of the precursor of 2M3MB in the brewhouse

- from wort kettle, whirlpool and wort cooler
- from the start of boiling to wort cooling
- at 50 HL test brewery and two practical-scale breweries (A and B)

Brewery	Capacity
Test Brewery	50HL / Brew
Brewery A	700HL / Brew
Brewery B	1,250HL / Brew



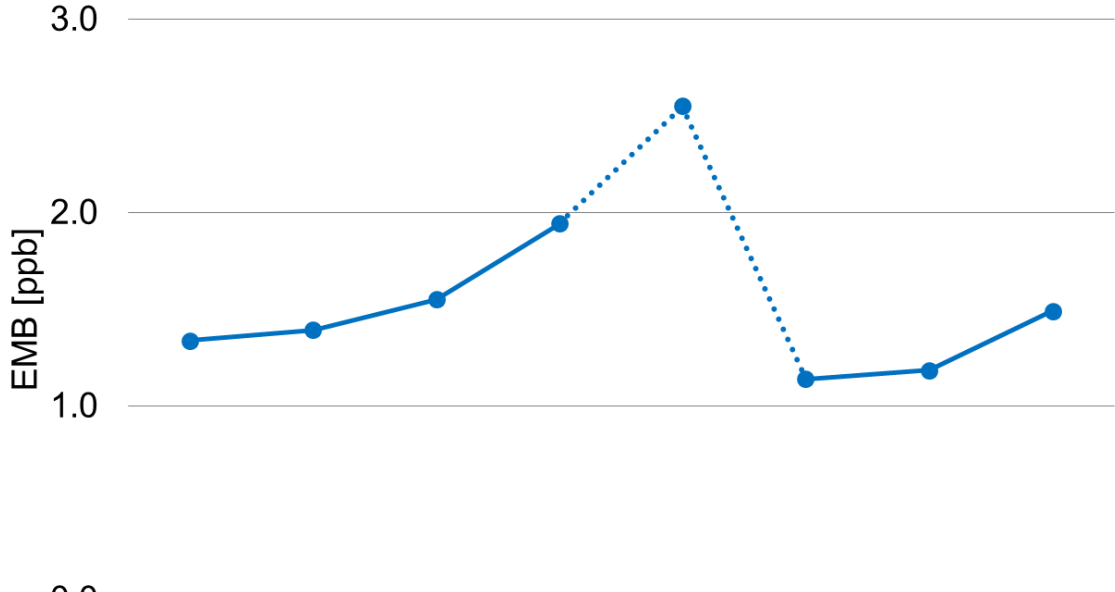
- Brewery A had higher levels of both 2M3MB and EMB than Brewery B.



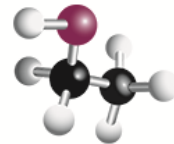
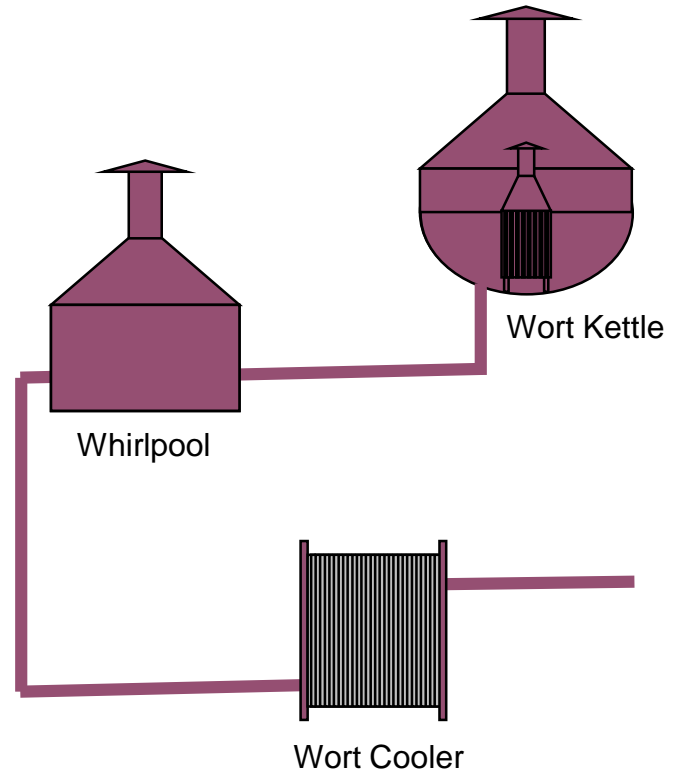
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## Precursor Content in 50HL Test-Brewery

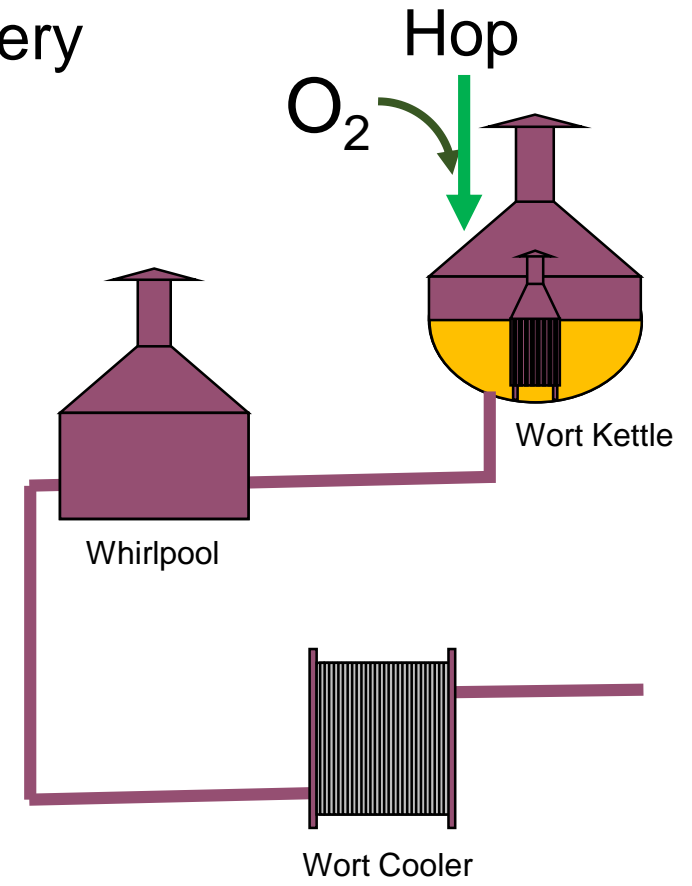
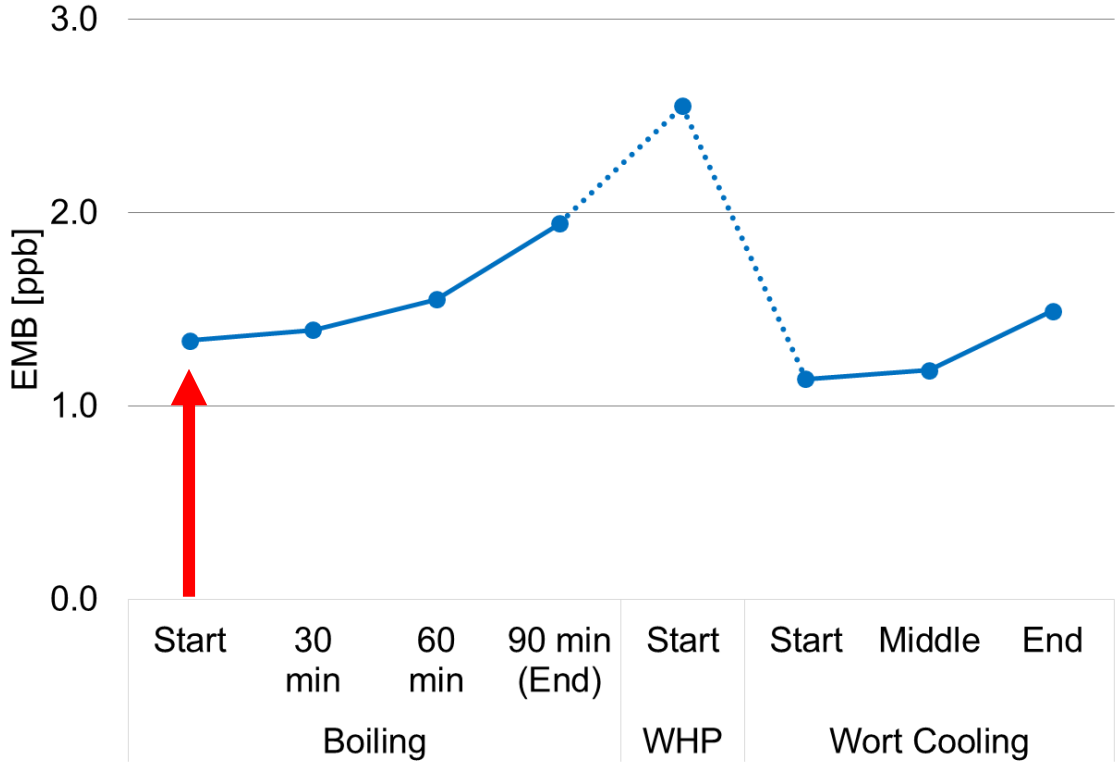


Start	30 min	60 min	90 min (End)	Start	Start	Middle	End
Boiling				WHP	Wort Cooling		

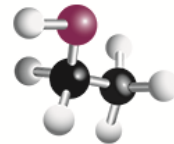


# Results and Discussion

## Precursor Content in 50HL Test-Brewery

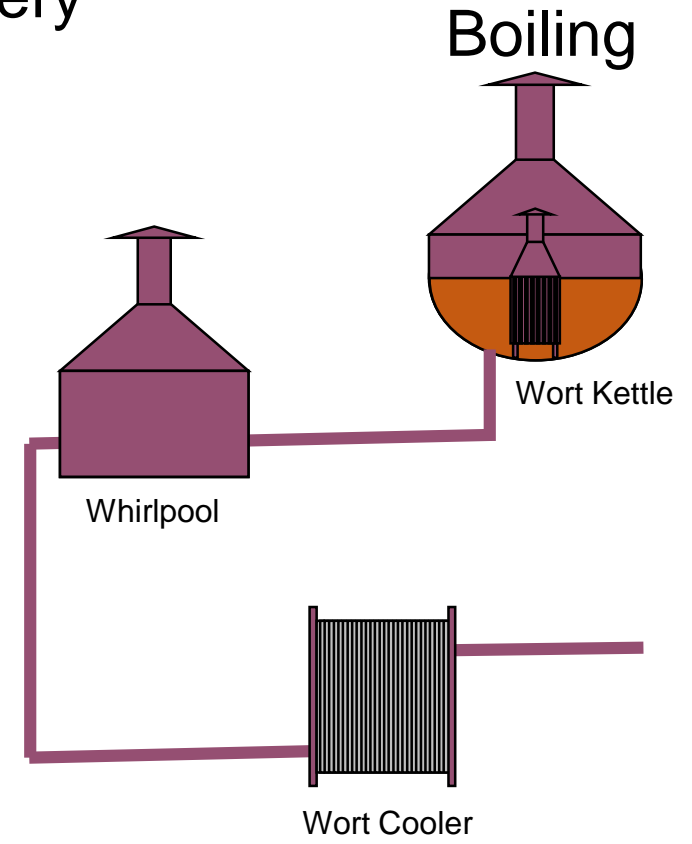
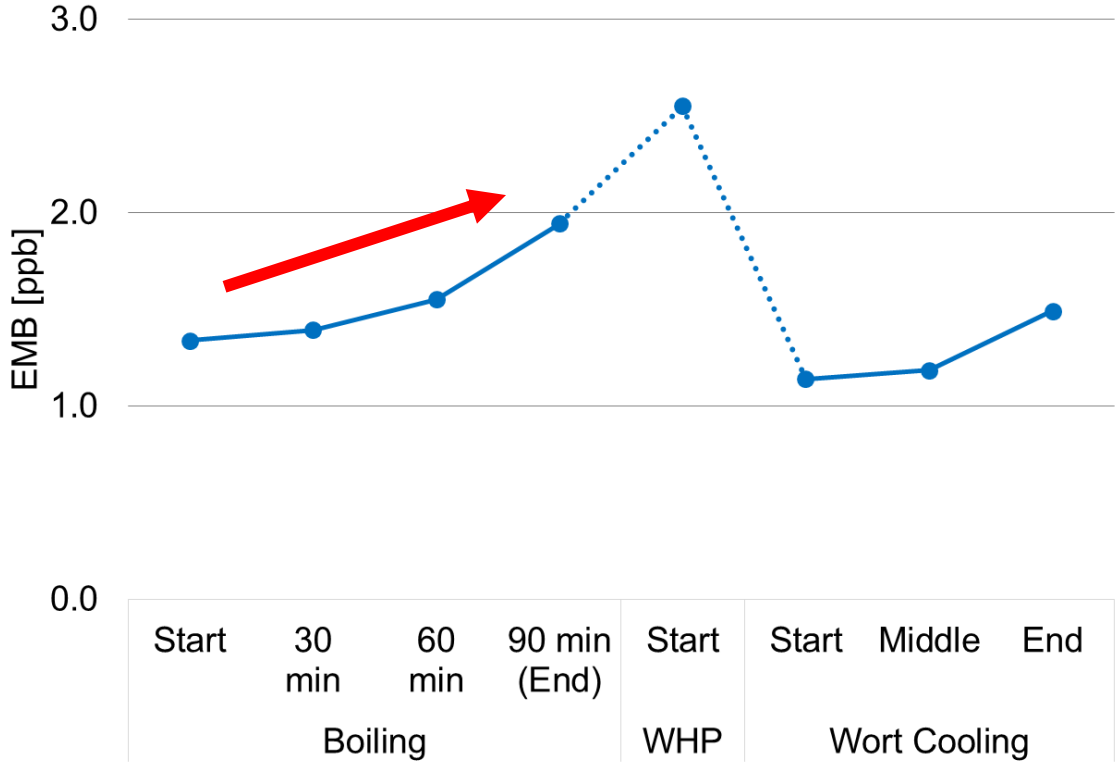


➤ EMB was already detected at the start of wort boiling.

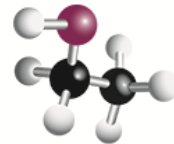


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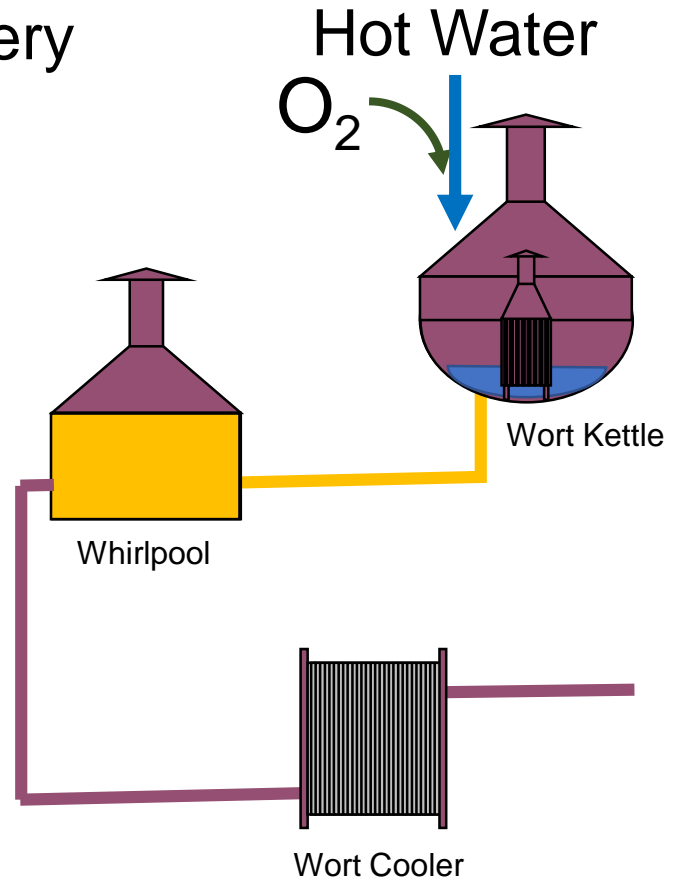
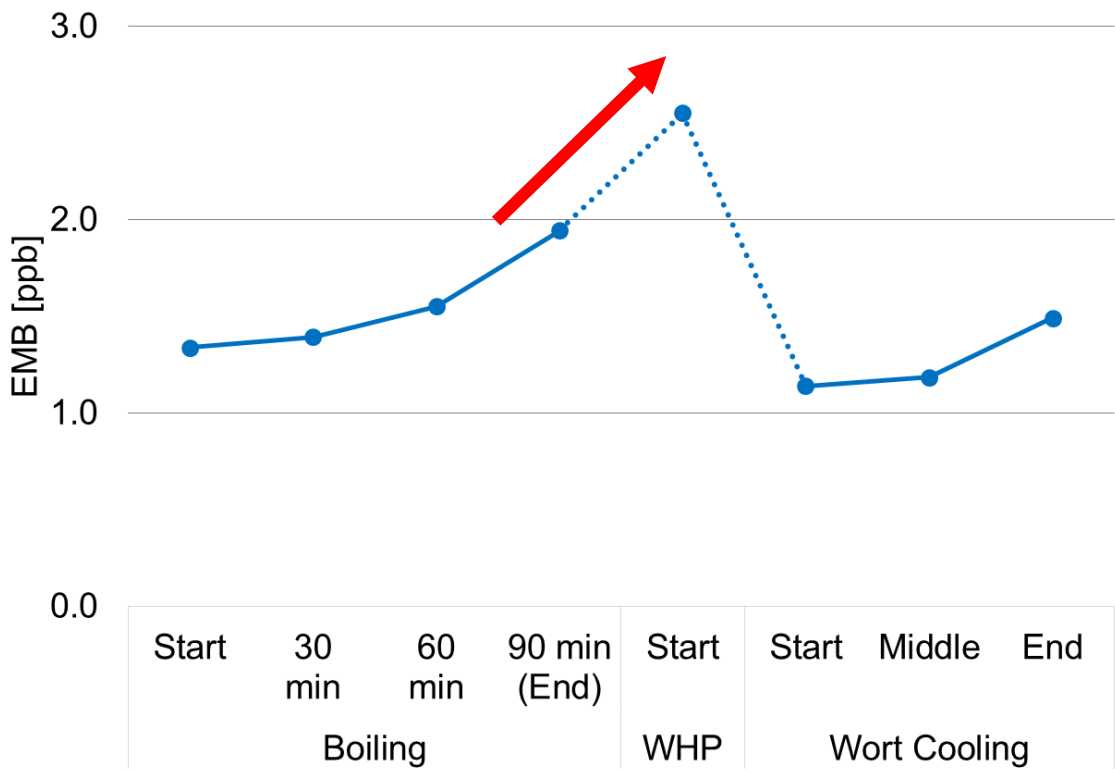
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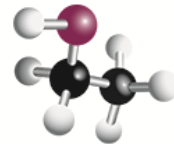
- EMB was already detected at the start of wort boiling.
- Level increased slightly through wort boiling.



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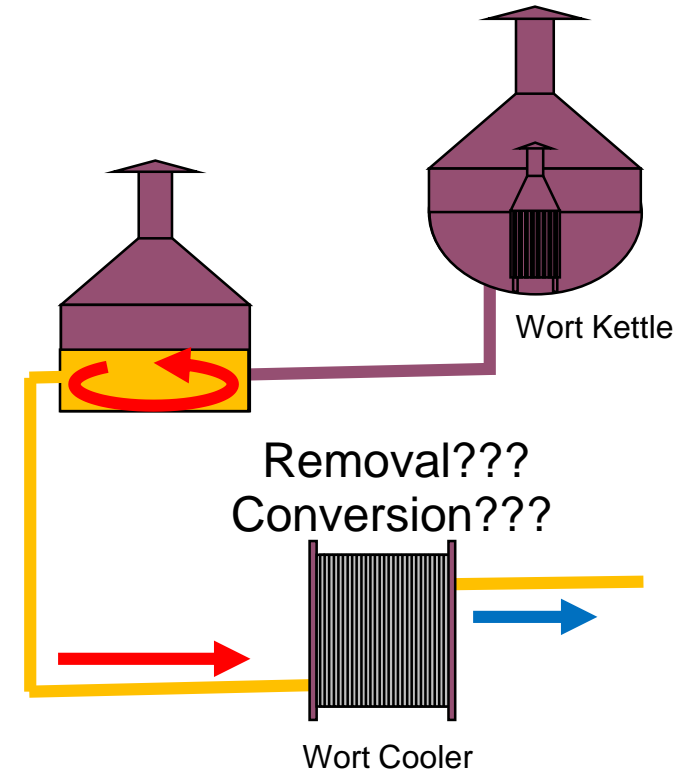
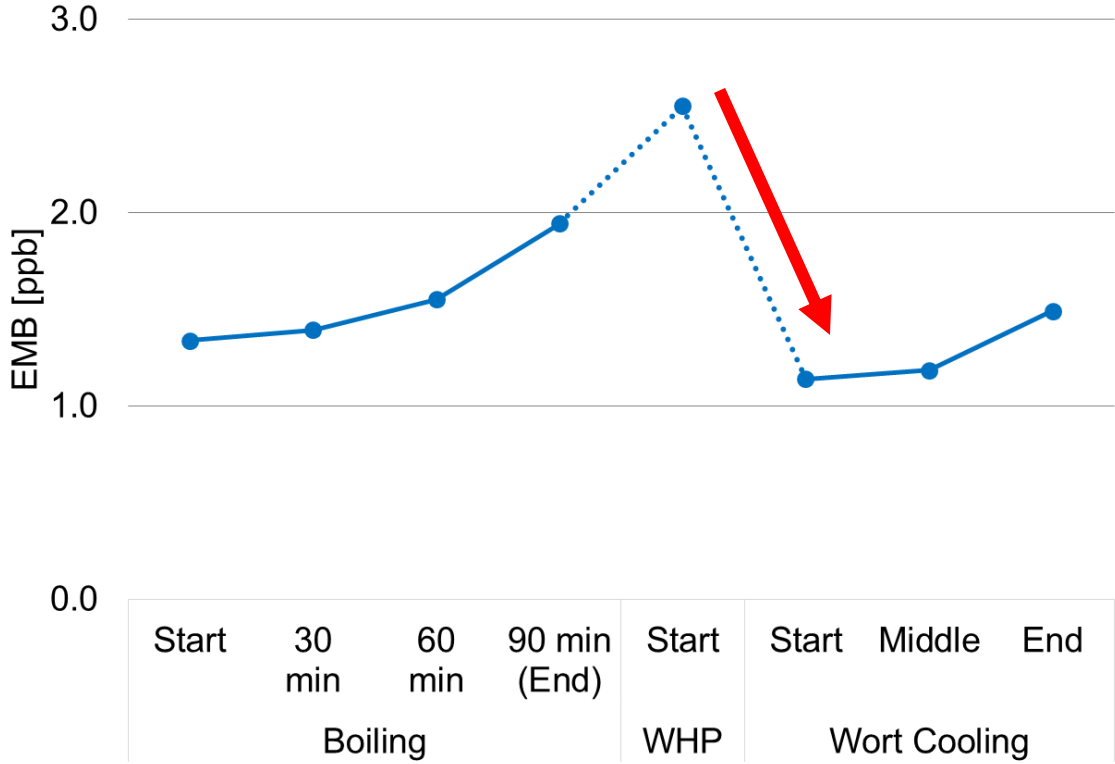


- EMB was already detected at the start of wort boiling.
- Level increased slightly through wort boiling.
- Level increased further at casting (transfer from Kettle to Whirlpool).

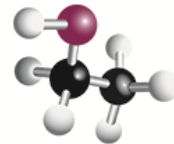


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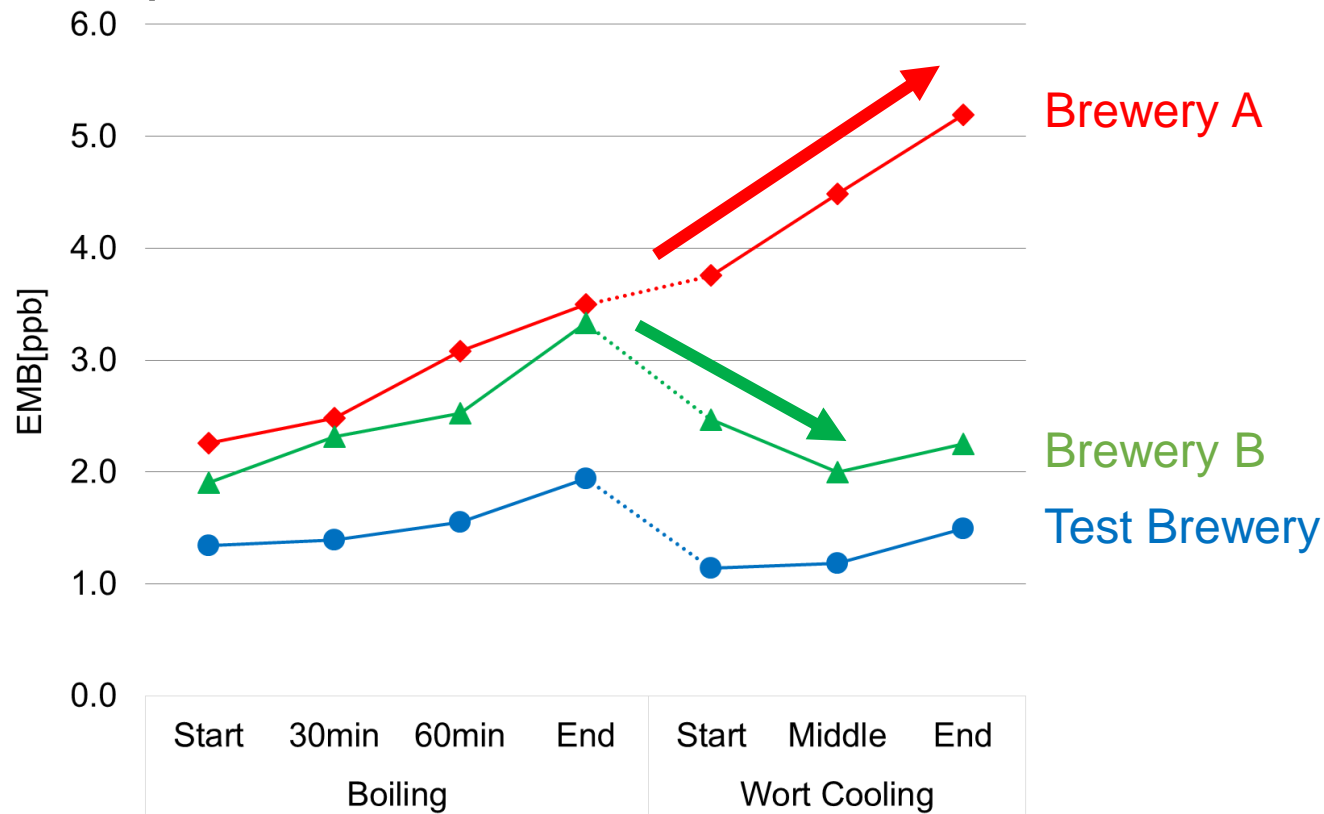
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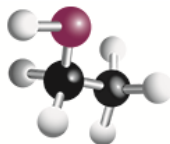
- EMB was already detected at the start of wort boiling.
- Level increased slightly through wort boiling.
- Level increased further at casting (transfer from Kettle to Whirlpool).
- Level decreased after cooling.



## Comparison between breweries

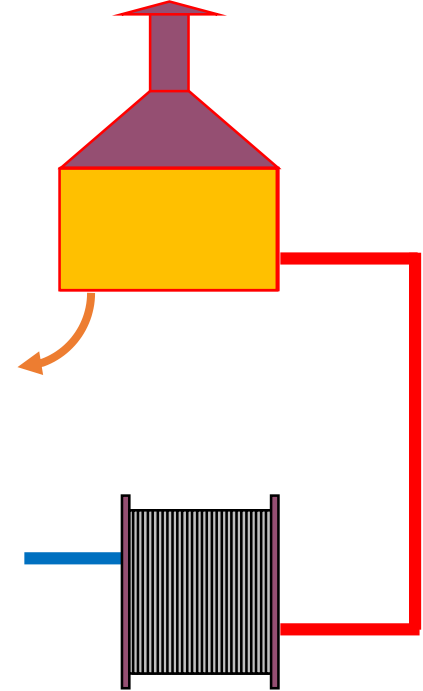
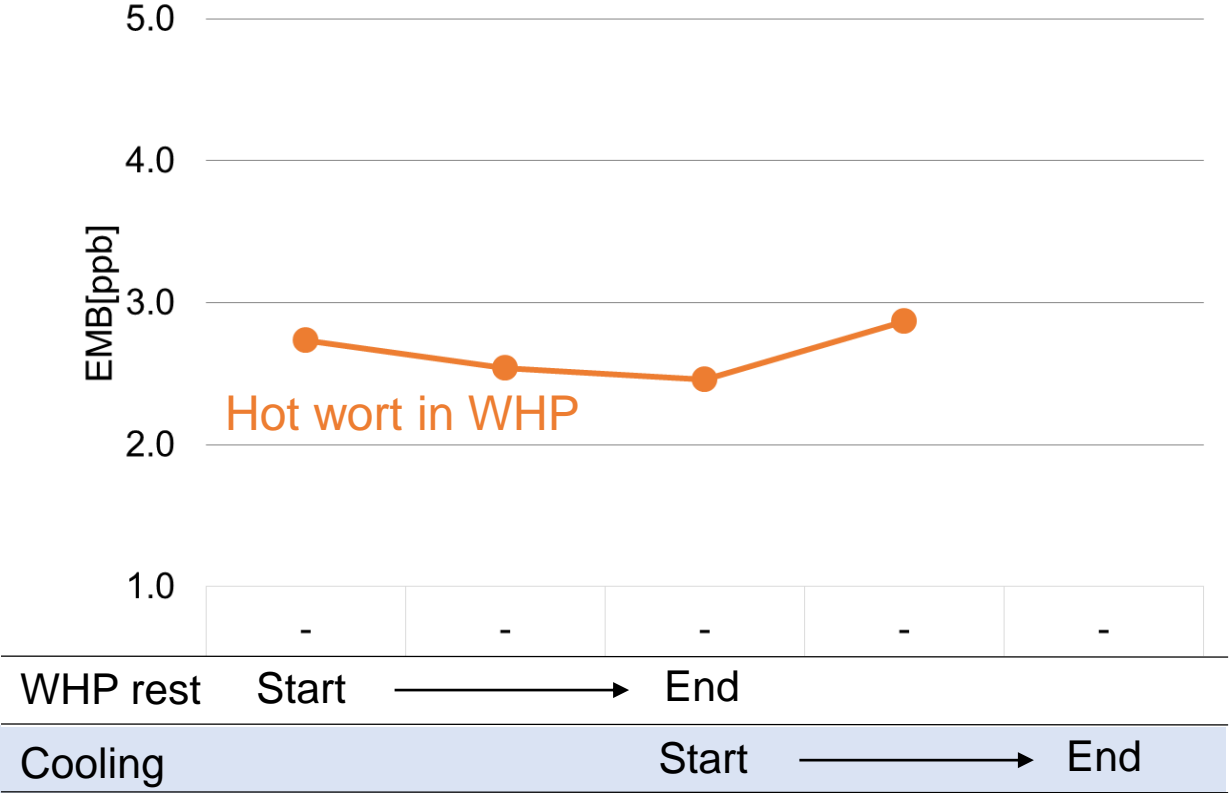


- Practical-scale breweries showed higher EMB level than test brewery.
- In Brewery A, EMB level did not decrease at the start of cooling, instead kept increasing during wort cooling.

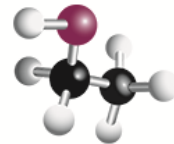


# Results and Discussion

## Precursor content after boiling at Brewery A

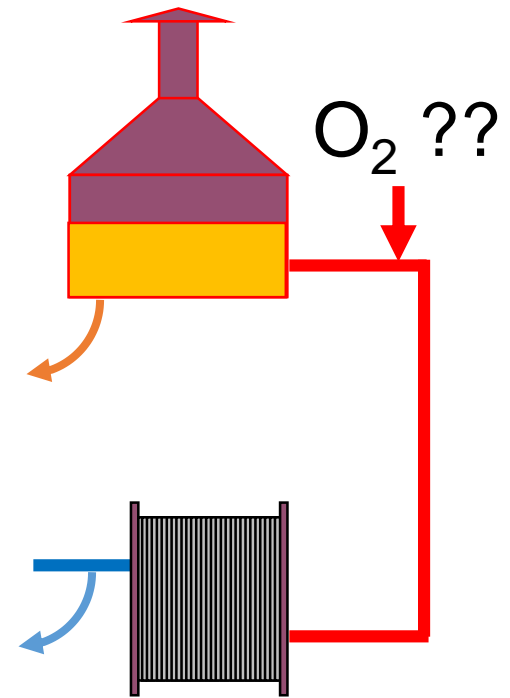
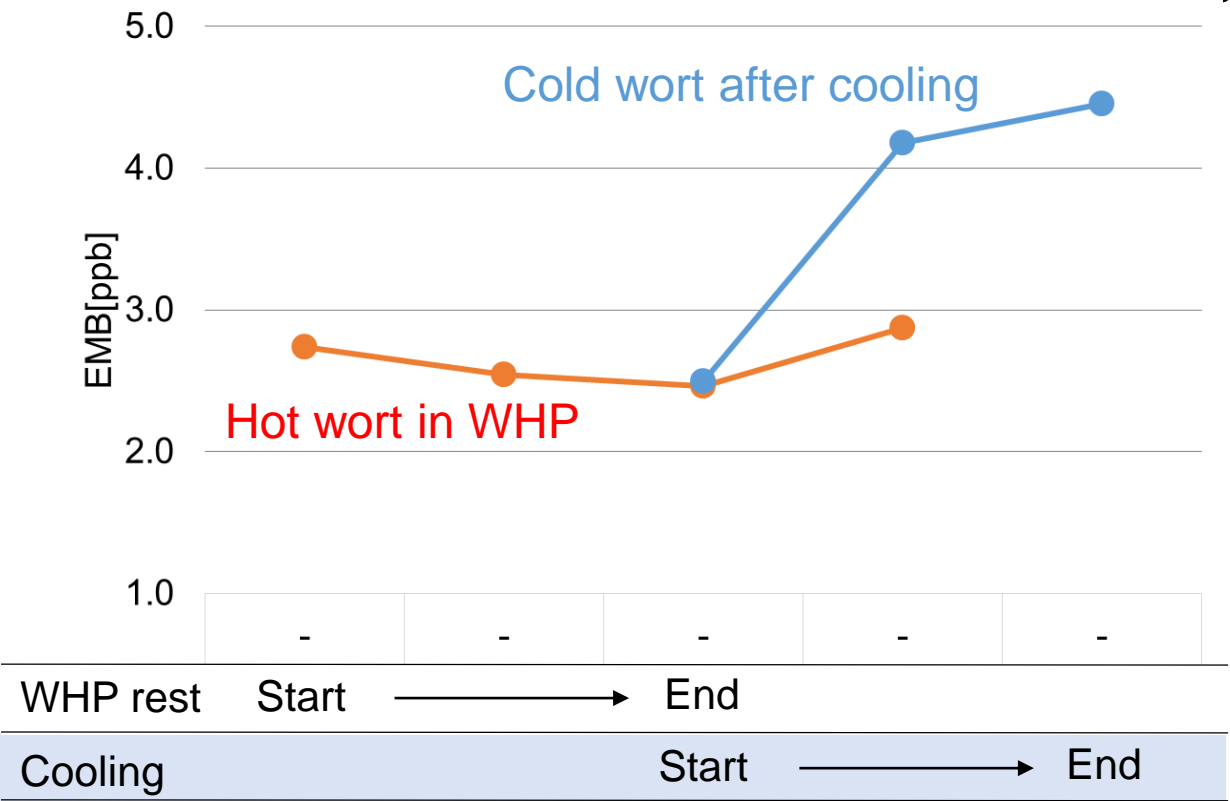


- In WHP, EMB kept almost the same level, even after the start of wort cooling.

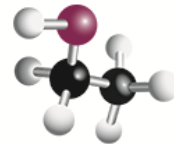


# Results and Discussion

## Precursor content after boiling at Brewery A



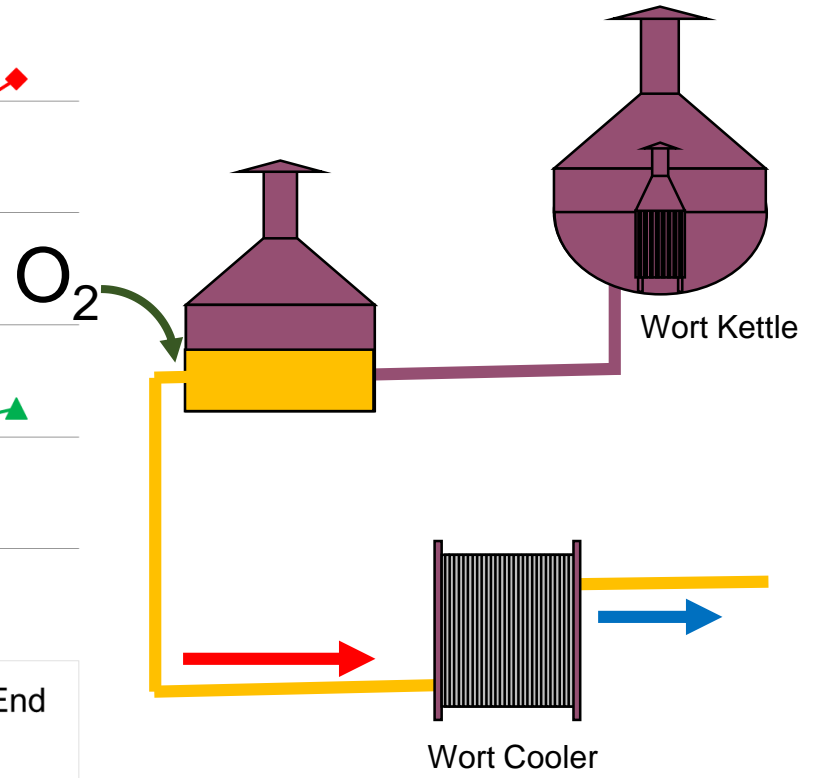
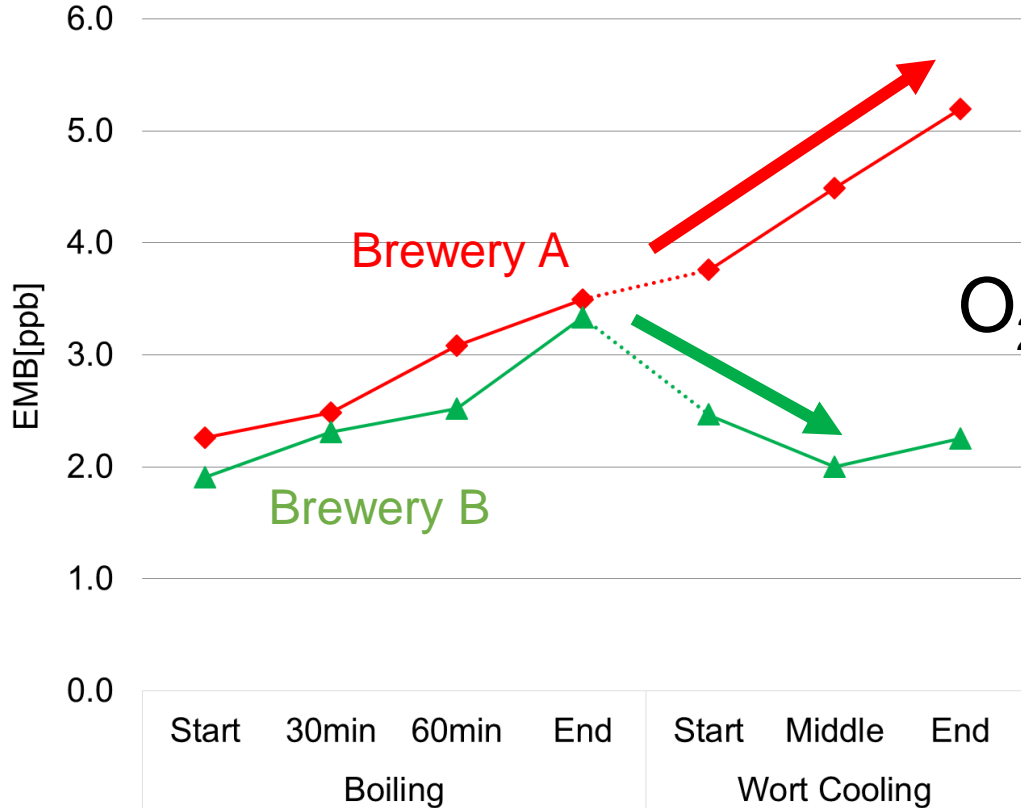
- In WHP, EMB kept almost the same level, even after the start of wort cooling.
- At the middle of wort cooling, an increase was observed.
- The result suggested that the increase occurred in the wort cooling line.



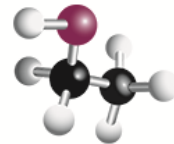


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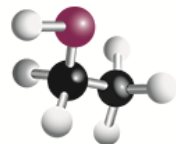
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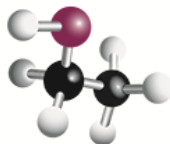
- In Brewery A, mixing with oxygen at the outlet of the WHP would occur
- We could specify the location in the brewhouse that affected the variability in EMB formation.



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- We monitored EMB (the precursor of 2M3MB) in the brewhouse at the test brewery and large-scale breweries.
- In hopping, boiling, and casting at all breweries, an increase in EMB level was observed.
- In cooling, test brewery and Brewery B showed decreased EMB levels, whereas at Brewery A a further increase was observed.
- Based on these results, we could specify the location in the brewhouse that affected the variability in EMB formation.

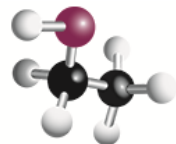


## Our Goals

- To identify factors that control 2M3MB levels
- To bring “onion-like” odor under control by changing factors

## Future Work

- Control the level of precursor in the brewhouse based on these results.
- Monitor the profile of H<sub>2</sub>S in our breweries, since this compound may affect variability in the conversion to 2M3MB.
- Identify other factors that control 2M3MB formation during fermentation.



# Thank you for your attention!

Taku Irie

Production Technology Center  
R & D Promotion Office  
Asahi Breweries, Ltd.  
e-Mail : [taku.irie@asahibeer.co.jp](mailto:taku.irie@asahibeer.co.jp)

**2017 ASBC Meeting**

