Case study of Memsys pilot plant to concentrate high TDS/COD wastewater (For ZLD) from coal-to-chemical (CTX) industry in China

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General procedure in CTX wastewater plant

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Industry wastewater collected from surrounding CTX plants

Biological treatment to reduce most of COD from wastewater

Sand filter

UF

RO

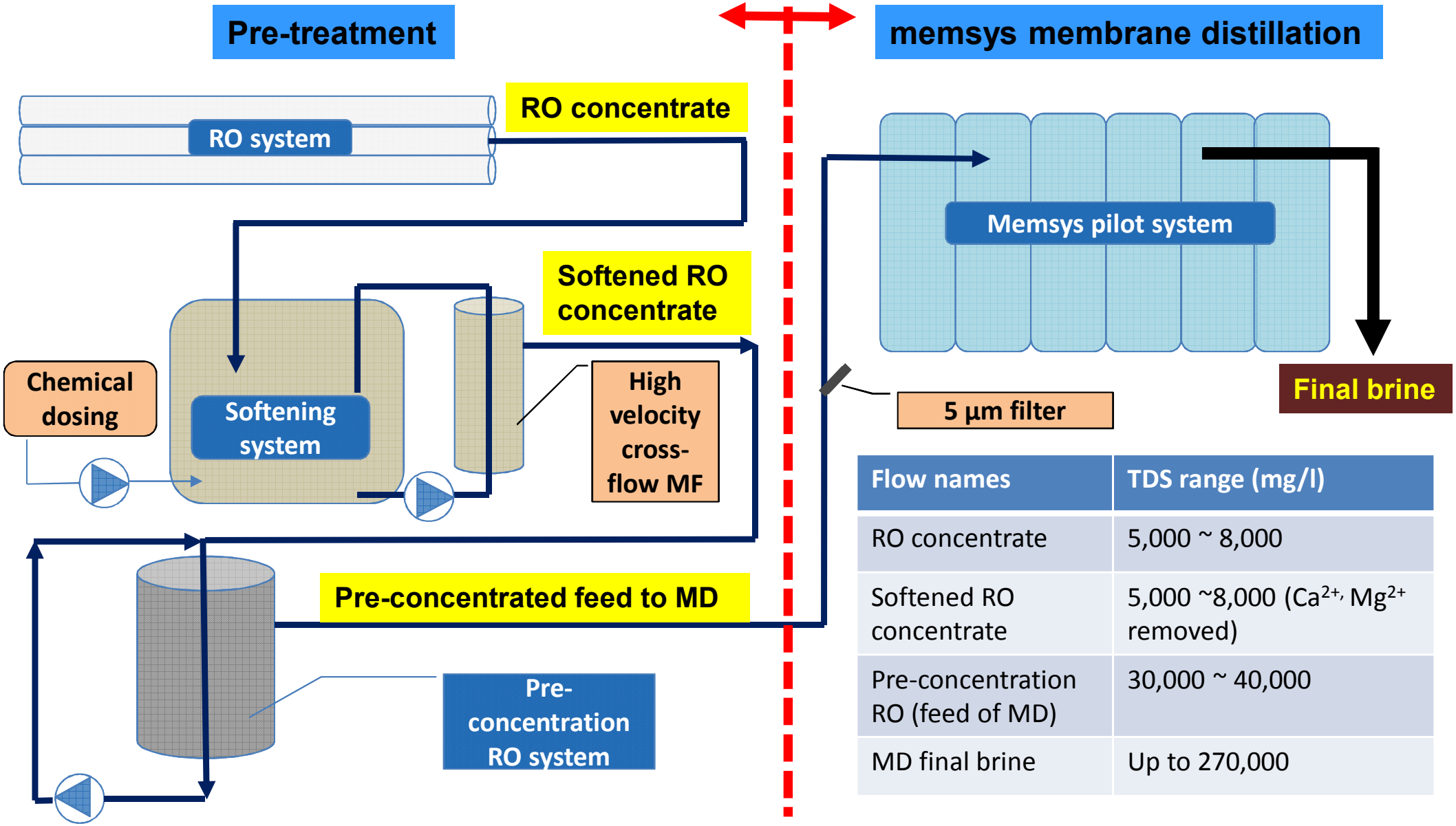
TDS of RO brine is only 5,000~8000 mg/l

Such as vibrating RO, High pressure RO, electrodialysis. The concentrating range of these processes are 30,000~80,000 mg/l TDS.

RO brine concentration

Evaporating pool

Process flow of Memsys pilot test



Flow names	TDS range (mg/l)
RO concentrate	5,000 ~ 8,000
Softened RO concentrate	5,000 ~8,000 (Ca^{2+}, Mg^{2+} removed)
Pre-concentration RO (feed of MD)	30,000 ~ 40,000
MD final brine	Up to 270,000

Memsys pilot system in the RO plant

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memsys pilot system had been run for 4 months in the RO plant for the RO brine concentration trial

Analysis of raw RO brine in the plant

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Typical analysis of raw RO brine

Items	Unit	feed
COD	ppm	142
pH		7.4
TDS	mg/l	5260
TSS	mg/l	0.45
Conductivity	µS/cm	7980
SO_4^{2-}	ppm	1680
Fe	ppm	1.86
Ba	ppm	1.91
Sr	ppm	19.1
Ca	ppm	671
Mg	ppm	275
SiO_2	ppm	71.6

1) The COD level in the RO brine is high;
2) There are significant Ca, Mg, Sr, SiO_2 and SO_4 in the feed, considering the high concentration target, a good softening process to remove scaling material such as Ca^{2+} and Mg^{2+} is very important, otherwise the performance and stability of MD process will be significantly affected

Water samples in the different concentration by Memsys

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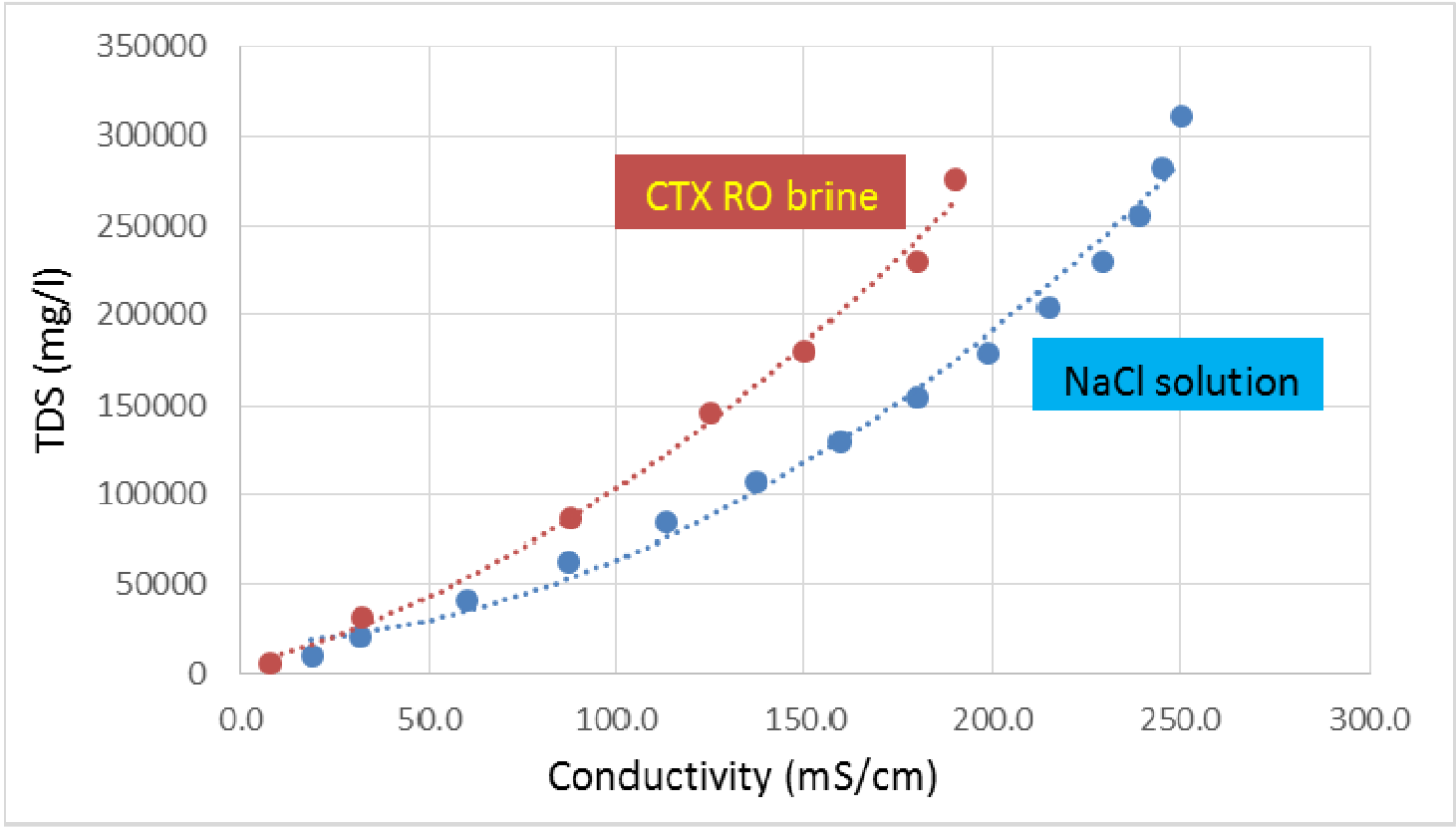
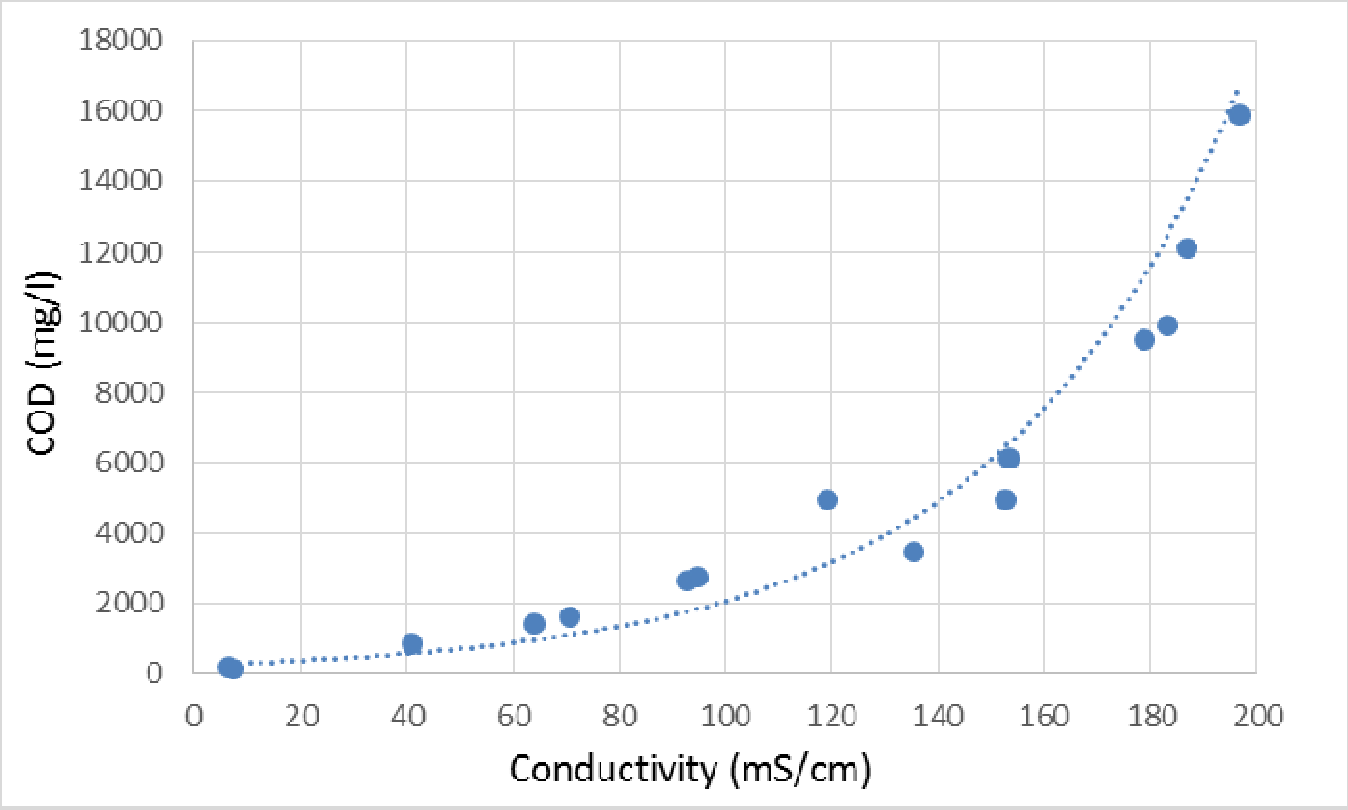
7000 µS/cm RO brine	40 mS/cm memsys brine	60 mS/cm memsys brine	150 mS/cm memsys brine	160 mS/cm memsys brine	170 mS/cm memsys brine	190 mS/cm memsys brine	40 µS/cm memsys Distillate

Relationship between conductivity and TDS



- **The maximum TDS this pilot testing reached is 270,000 mg/l (190 mS/cm);**

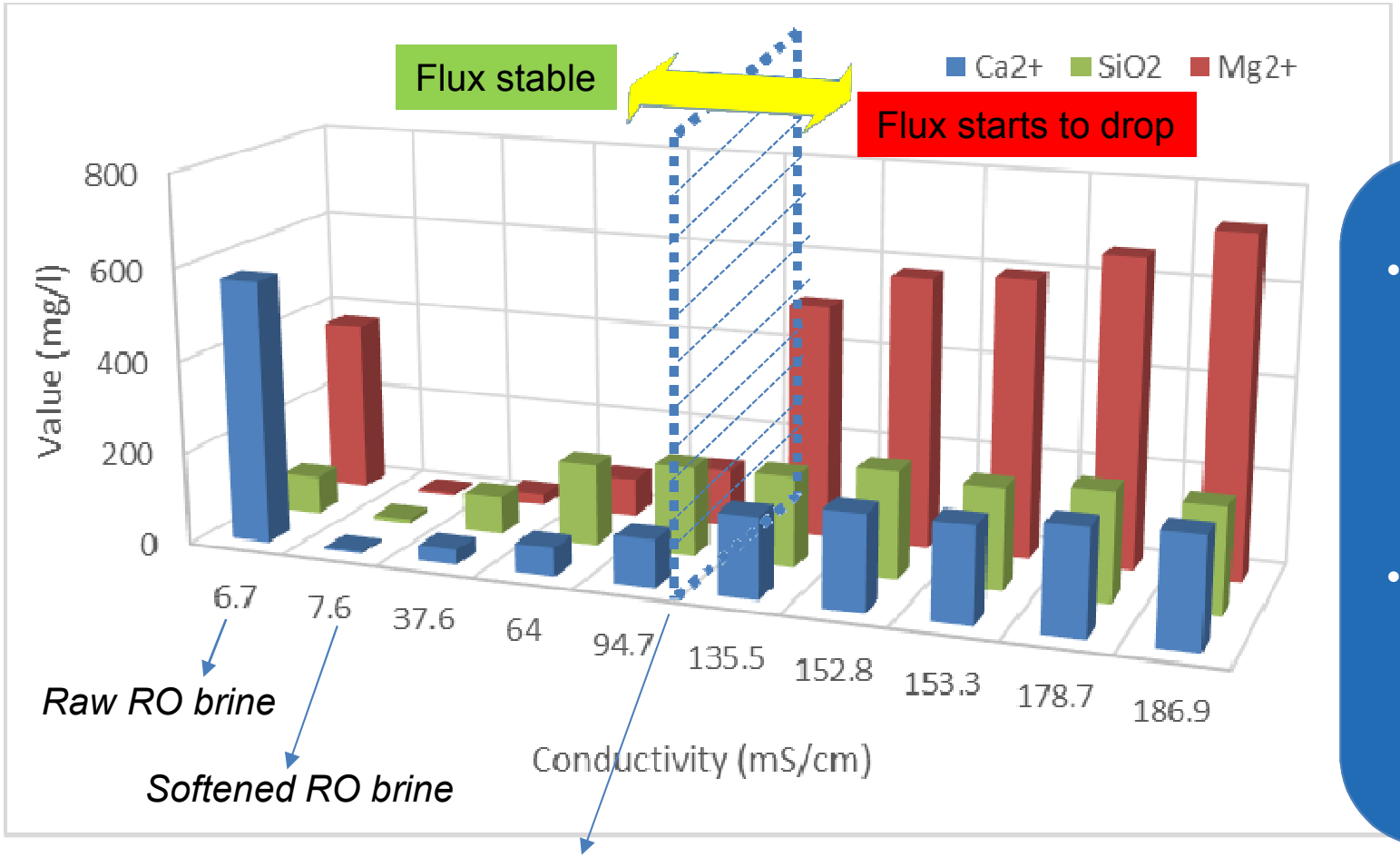
Relationship between conductivity and COD



The high concentration of Cl^- might affect the accuracy of this COD result, but we believe the max. COD this testing reached was over 10,000 mg/l

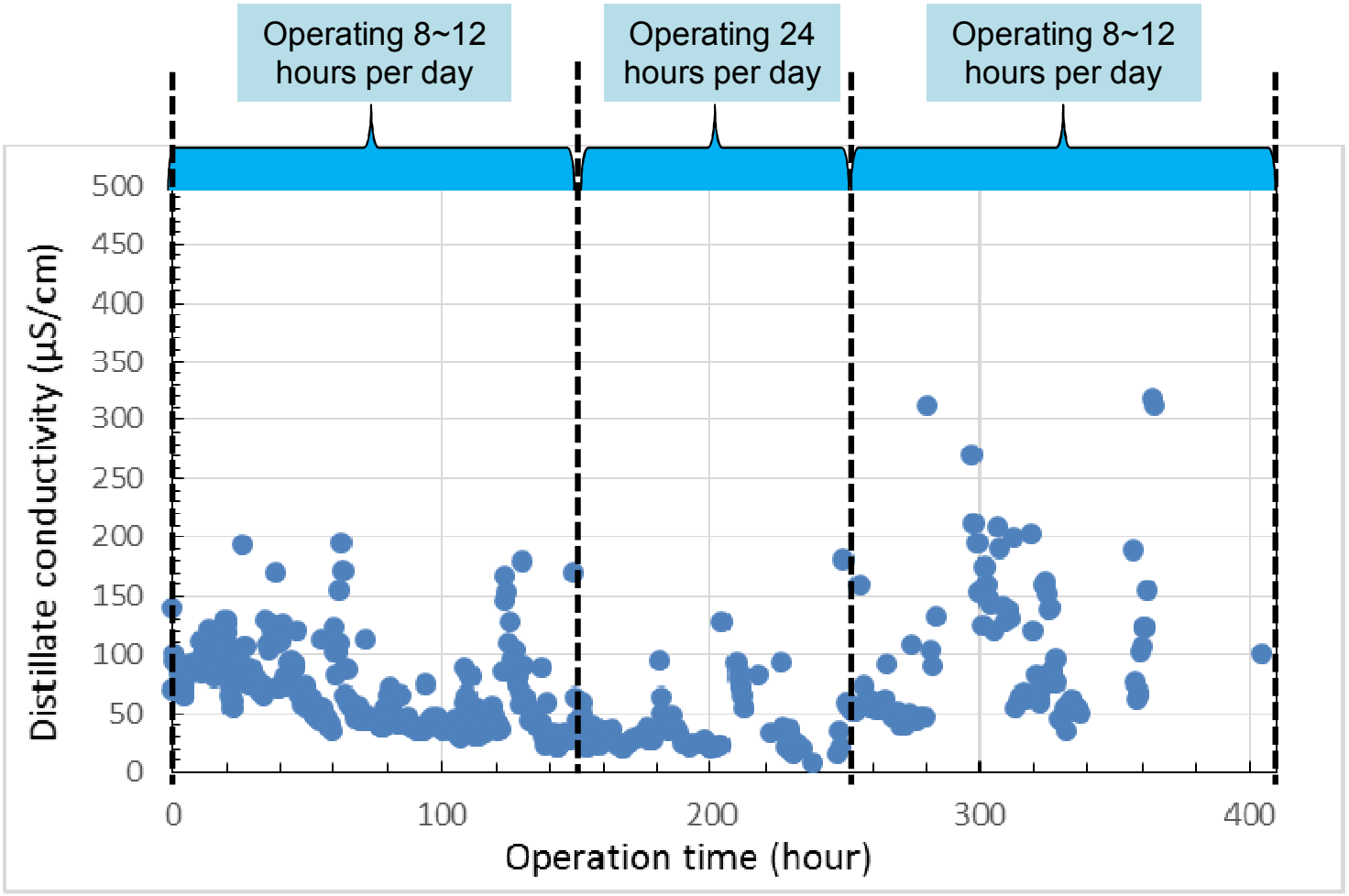
- Memsys module can handle very high COD level in the concentrating process;
- High COD could change evaporating property of the feed, but shows very minor effect on the flux stability and distillate quality;
- The components of COD is not fully identified, considering many upstream dosing process and the wastewater was originally from methanol plant, this COD composition could be very complicated;

Ca^{2+}, Mg^{2+} and SiO_2 analysis in the different concentration



- After softening, the flux is quite stable until the brine concentration is higher than 120 mS/cm;
- $CaSO_4$ and SiO_2 could be the main scaling material in the flow;

Distillate quality during whole piloting period



- **The conductivity of distillate is all the time stable and not affected by TDS and COD level;**
- **The distillate quality of 24 hours operation mode is better;**
- **NH_3-N was detected in the distillate**

Chemical cleaning in place (CIP)

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CIP procedure		
Sequence	**Duration (min)**	**T1-1**
Water flush	15 (until brine concentration < 10 mS/cm)	60 °C
NaOH (1%) flush	30 min	60 °C
Water flush	15 min	Stop heating
HCl (1%) flush	30 min	Stop heating
Water flush	15 min	Stop heating
	Total: 1 h 45 min	

The comparison of high TDS sample with and without softening process

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Without softening

Fresh brine (140 mS/cm) collected from brine line,

With softening

Fresh brine (190 mS/cm)

Comparison of flux stability with and without softening process (70 °C heating condition)

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