Outline of Ammonia Re-utilization Ash and Waste Sludge Reduction on Unique AWMT System in Commercial Application for Heavy Oil-Fired Thermal Power Station

SATORU SUGITA*1
HIROSHI NAKASHOJI*1
SUSUMU OKINO*2
TSUMORU NAKAMURA*2

1. Introduction

The combustion ash collected at heavy oil fired thermal power plants by electrostatic precipitators (flyash) is treated as industrial waste, because the flyash contains heavy metals and other substances.

Furthermore, the flyash is generally humidified to prevent possible secondary pollution caused by scattered ash.

On the other hand, due to high content of sulfur in heavy oils, large quantity of ammonia needs to be injected to prevent sulfuric acid corrosion into the flue gas treating section most of which gets discharged getting contained in flyash and FGD wastewater.

From the point of environmental concerns, it is desirable to remove ammonia from flyash and FGD wastewater.

Mitsubishi Heavy Industries, Ltd. (MHI) has developed a system that does not discharge any wastewater known as the Ash/Wastewater Mixture Treatment (AWMT) System in cooperation with Chubu Electric Power Co., Inc. through demonstration tests during a four year period from 1993 to 1997.

The AWMT system recovers ammonia by mixing flyash with FGD wastewater. The ammonia thus recovered is then recycled to the ammonia injection, while reducing the amount of waste produced and establishing a non-wastewater discharge system.

The first commercial plant of AWMT system was constructed at the Yokkaichi Kasumi Power Station of Cosmo Oil Co., Ltd. The plant has been operating for over one year in a favorable state.

This paper presents a brief outline of the AWMT system.

2. Outline of Facilities

(1) Features of AWMT system

The AWMT system has three major characteristics, outlined below.

- Reduction of the amount of industrial waste produced

  The amount of industrial waste is reduced by means of dissolving ammonium sulfate containing approximately 65wt% (Note 1) in flyash for removal.
- Reduction of the amount of ammonia injection by recycling

  Recovering from the solution containing ammonium sulfate as ammonia, and reusing reduces the total amount of ammonia.
- Non-discharge of FGD wastewater

  Evaporating and drying the residual liquid after ammonia recovery attains the non-discharge of FGD wastewater. Which contributes to protection of environmental pollution.

(2) Process flow

Figure 1 shows the process flowchart of the AWMT system. A notable feature of the AWMT system is the adoption of a forced circulation vacuum evaporator in the ammonia recovery section. The evaporator allows the gypsum to grow from seed crystals of dehydrated gypsum, thereby recovering the ammonia without any scaling of gypsum on the inner surfaces of the heat exchanger and the evaporator.

(3) Outline of power plant and environmental facilities

- Generator output: 223 000 kW
- Fuel: Vacuum residue (VR)
- FGD facility: wet limestone gypsum process

(4) Outline of AWMT system

- Handling capacity of FGD wastewater: 2.6 t/h (Note 2)
- Handling capacity of flyash: 1.1 t/h (Note 2, Note 3)
- Reduction rate of industrial waste: 40 % (Note 3)
- Recovery rate of ammonia: 90 %
- Wastewater discharged: Non-discharge

*1 Plant and Transportation Systems Engineering & Construction Center
*2 Hiroshima Research & Development Center, Technical Headquarters

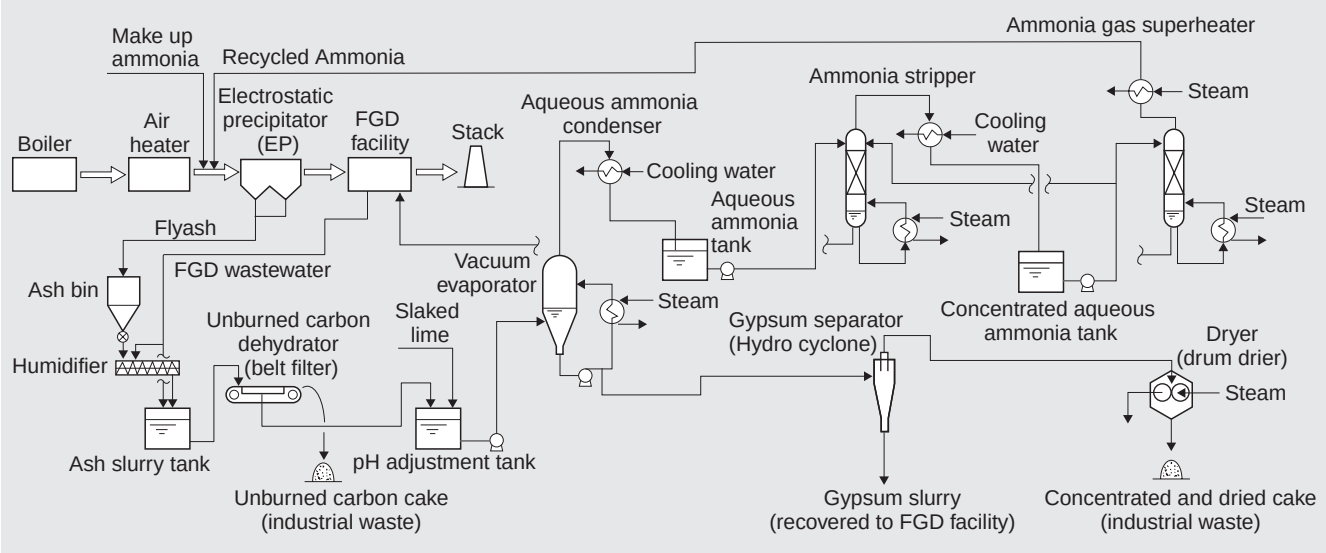


Fig. 1 Process flow chart of AWMT system

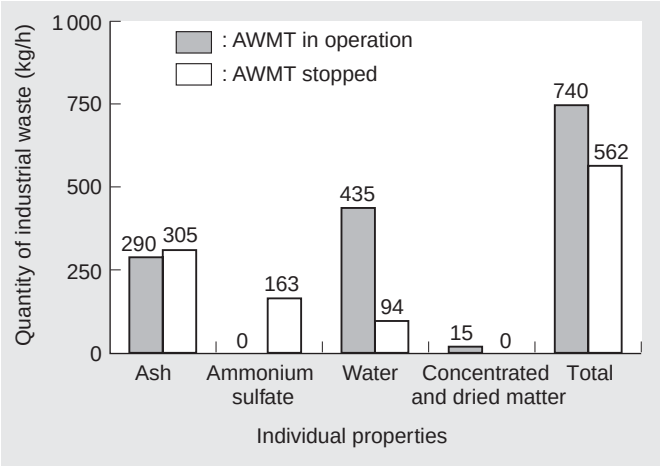


Fig. 2 Comparison of quantity of industrial waste produced
Ammonium sulfate in ash is completely removed, which suggests that the ammonium sulfate removal rate in a state of increased SO3 conversion rate has reached the expected level.

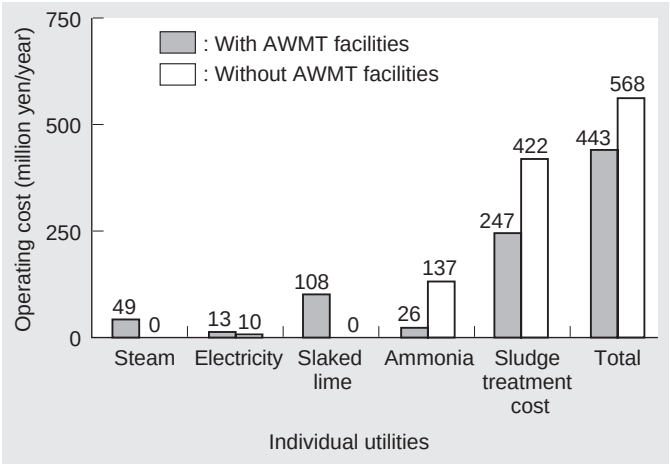


Fig. 3 Comparison of utilities consumption
Installation of the AWMT system results in reduced utility usage costs amounting to approximately 130 million yen per year.

3. Outline of Performance

(1) Reduction in amount of industrial waste produced

Figure 2 shows a comparison between the estimated quantity of industrial waste produced by operating and not operating AWMT system.

Actual operation results in a low SO_3 conversion rate in the boiler so that the percentage of ammonium sulfate in the flyash became small. Nevertheless, the removal rate of ammonium sulfate was very close to 100 %, which suggests that the reduction rate of industrial waste under designed SO_3 conversion rate will be at the expected level.

(2) Ammonia recovery performance

The ammonia recovery rate in the AWMT system was approximately 90 %, which satisfies the designed level. In addition, it was confirmed that the amount of ammonia recovered could be recycled as injection ammonia.

(3) Non-discharge of wastewater

It was confirmed that operation of the facilities is quite effective in achieving no discharge of wastewater, and that the AWMT system significantly contributes to a reduction of environmental pollution.

4. Evaluation of Economic Benefits

Figure 3 shows a comparison of the utilities with conventional systems. **Table 1** lists the conditions used in the evaluation.

The evaluation showed that a cost reduction of about 130 million-yen a year could be achieved using the system owing to the significant savings in the cost of the ammonia recycle used and the reduction of costs required for sludge treatment.

Table 1 Conditions for estimating AWMT system utilities

Item		Value
1. FGD wastewater/Flyash	(t/h)	2.6/1.1
2. Annual operating days	(day)	330
3. Boiler SO_3 conversion rate	(%)	6
4. Facilities compared ● FGD wastewater treatment system: Duct-spraying wastewater evaporation system ● Ash treatment system: Handling as Industrial waste after humidifying and packaging in flexible container		

5. Conclusion

This paper gave a brief introduction of the AWMT system's commercial application. The system not only significantly contributes to realizing global environment protective measures such as the effective use of recycled ammonia, reduction of industrial waste, and the non-discharge of wastewater, but also to realizing significant reduction in utility costs.

MHI intends to introduce the results of commercial application of the AWMT system and to move ahead with studies aimed at achieving further improvements in the AWMT system.

The authors would like to express their sincere appreciation to Chubu Electric Power Co., Inc. and to Cosmo Oil Co., Ltd. for their special support in testing and commercializing the AWMT system.

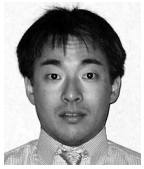
Note 1: The value is an estimated value at 6% of boiler SO_3 conversion.

Note 2: The value is the designed value at maximum boiler load.

Note 3: The value is the designed value at 6% of boiler SO_3 conversion rate.

Reference

(1) Kojima et al., The Thermal and Nuclear Power No.493 Vol.48 (1997) p.80



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Susumu Okino

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