Reduction of CO_2 Emission in LRC Power Plant by LRC Drying and Simulation by Coal Quality Evaluation System (C-Quens)

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Background and Objective

- Low rank coal (LRC) contains significant amounts of moisture, which decreases the overall plant thermal efficiency.
- As a result, the specific CO_2 emission is increased. To reduce the CO_2 emission, an improvement of the thermal efficiency is desired.
- External drying technologies are one of the solution for CO_2 mitigation of LRC power plants.
- Computer simulation studies were carried out to evaluate CO_2 emission of a 315 MW LRC power plant with and without an external drying process.

LRC Power Plant with STD for Simulation

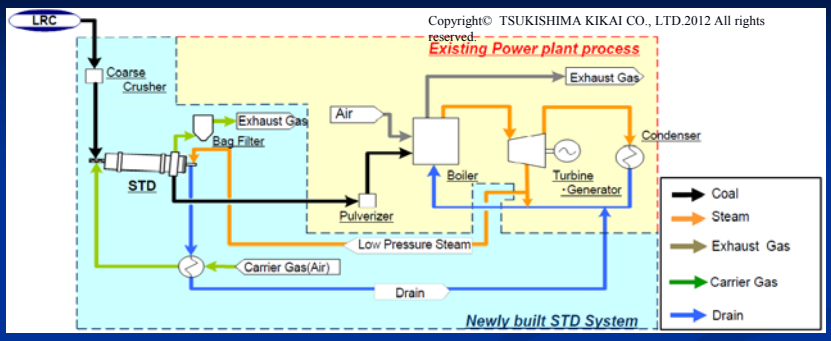

Fig. 1 Coal fired power plant with a steam tube dryer

Table 1 Coal properties

Total moisture, % ar	35.0	Calorific value, kcal/kg, ar	4028
HGI	49	Ash, %, ar	2.3
Carbon, %, daf	70.8	Volatile matter, %, ar	34.1
Oxygen, %, daf	23.7	Fuel ratio (= FC/VM)	0.84

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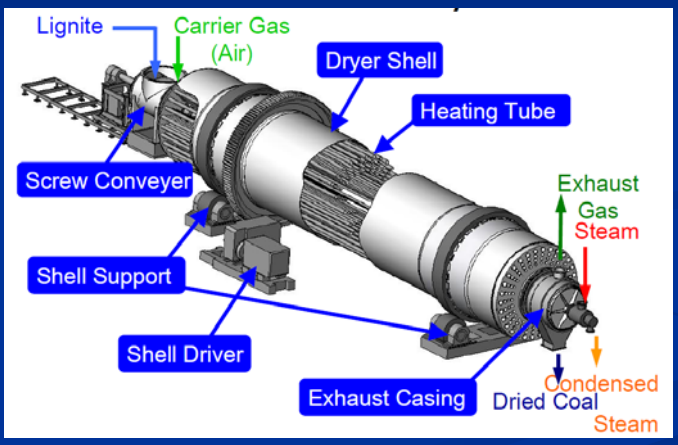
Outline of Steam Tube Dryer (STD)

STD has shell and tube. Coal is dried in shell by heat transfer from heating tubes.



By 1 unit STD, moisture is reduced to 25% from 35%.

By 2 unit STDs, moisture is reduced to 11.4%.

(Coal consumption is about 170 t/h at 315 MWe)

Fig.2 Outline of a steam tube dryer

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Outline of Simulator (C-Quens)

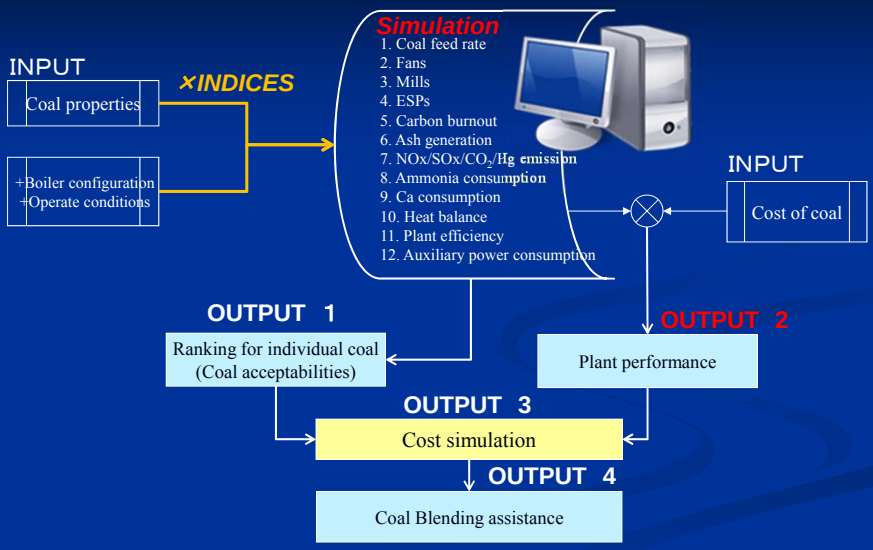

Fig.3 Outline of "Coal Quality Evaluation System (C-Quens). 5

Detailed simulation flows in C-Quens

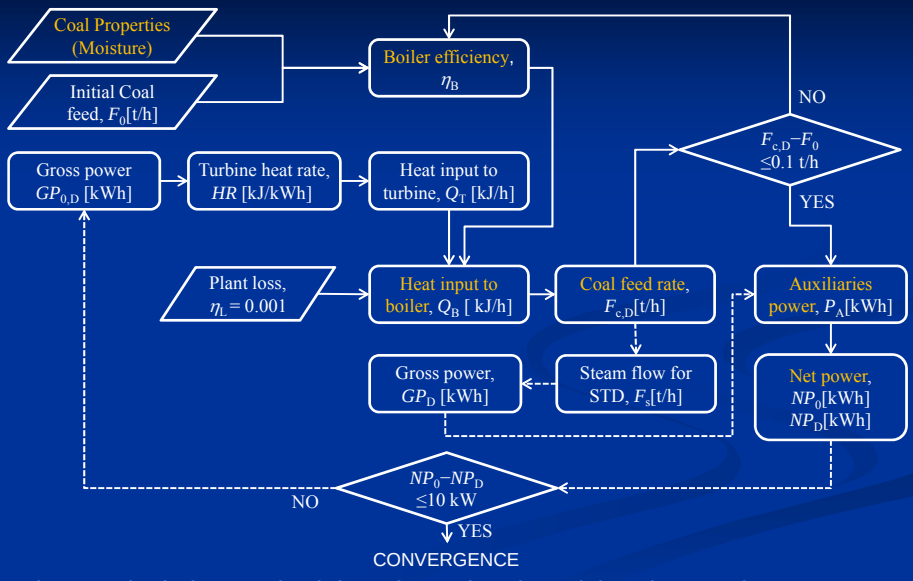

Fig.4 Calculation methodology for estimation of the plant performance. 6

Simulation Conditions

5 case studies were carried out.
Baseline (without STD), 1 STD at full load, 2 STD at full load, 1 STD at 75% load, 1STD at 50% load.

Table 2 Simulation conditions of a 315 MW power plant with and without STD.

	Unit	Baseline	1 unit STD	2 unit STD	75% load 1 STD	50% load 1 STD
Net power	MW	302.1	302.1	302.1	214.2	141.7
Total moist.	%	35.0	25.0	11.4	25.0	25.0
Steam temp.	℃	–	342	342	340	322
Steam flow	t/h	–	30.8	60.4	22.0	15.5
Steam press.	MPa	–	0.862	0.862	0.619	0.438
Steam temp. at STD exit	℃	–	172.2	172.2	158.8	145.7

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Result 1: Boiler efficiency

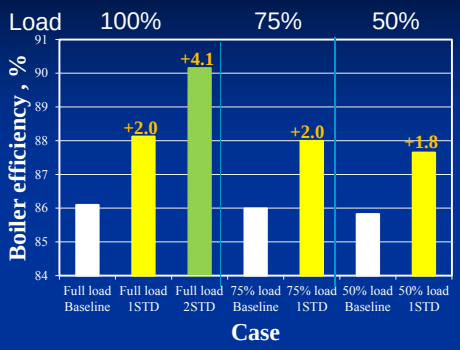

Fig.5 Improvement of boiler efficiency by the addition of STD(s) . Moisture is 35% in baseline, 25% in 1STD, and 11.4% in 2STD.

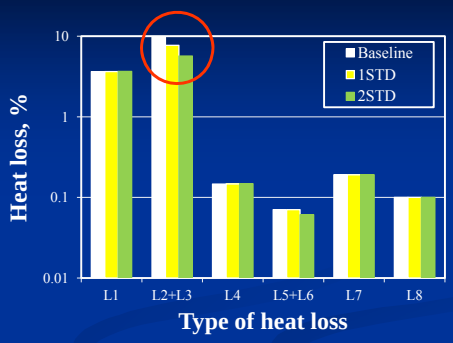

Fig.6 Different in heat loss in boiler by the addition of STD(s) .

L1: Dry flue gas
L2: Hydrogen in fuel
L3: Moisture in fuel
L4: Humidity in air
L5: Unburned carbon
L6: Unburned gas
L7: Heat transfer
L8: The others

Boiler efficiency is increased by 2.0% points by the addition of one STD due to the improvement of heat loss in the boiler by moisture in coal.

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Result 2: Net thermal efficiency

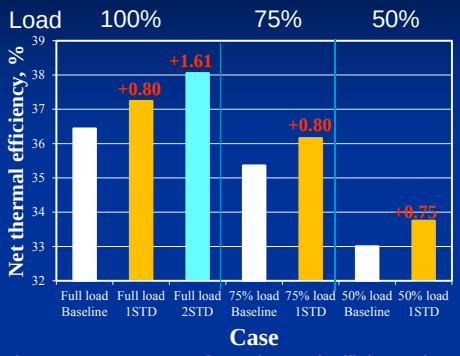

Fig.7 Improvement of net thermal efficiency by the addition of STD(s) .

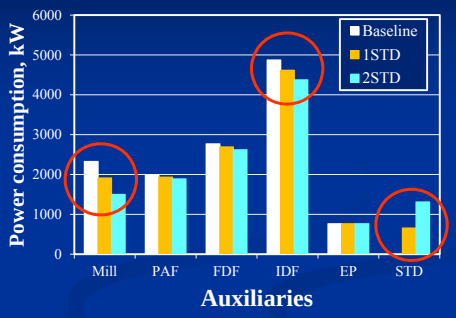

Fig.8 Different in heat loss in boiler by the addition of STD(s) .

Net thermal efficiency is increased by 0.8% points by the addition of one STD.
A decrease in power consumption of mills and fans is greater than an increase in power consumption of the STD(s).

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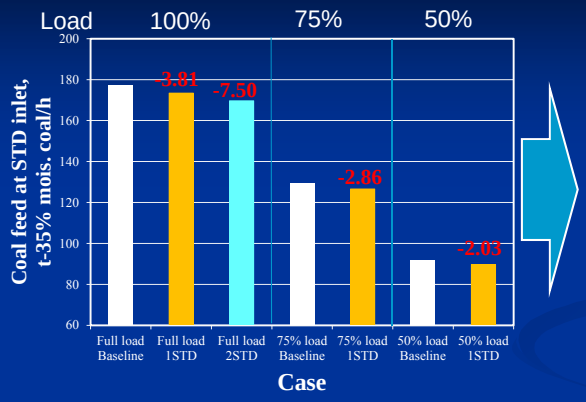
Result 3: Coal Consumption and CO_2 emission



Case	CO_2 mitigation, t-CO_2/year
Full load 1 STD	54,000
Full load 2 STD	112,400
75% load 1 STD	43,000
50% load 1 STD	30,400

Fig.9 Saving of fuel consumption by the addition of STD(s) .

Coal consumption is reduced by 3.8 ton/h by the addition of one STD.
For a year, 33,400 ton coal can be saved at full load.
As a result, 54,000 ton-CO_2/year is mitigated.

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Conclusions

The thermal efficiency and CO_2 emission of a 315 MW LRC power plant with and without STD(s) were estimated by C-Quens. The results are concluded as follows:

- By one STD addition, total moisture in coal was dried to 25% from 35%.
- Boiler efficiency was increased by 2.0% points by the improvement of boiler efficiency.
- Net thermal efficiency was increased by 0.8% points by the decrease in power consumption of auxiliaries.
- 54,000 ton-CO_2/year was mitigated at a full load condition.