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EXPERIMENTAL RESEARCHES FOR THE REDUCTION OF THE NOXES DURING THE BURNING OF PIT COAL FROM JIU VALLEY – ROMANIA

The paper summarizes measurements conducted on a pilot combustion installation in liquefied layer, used in experimental activity when functioning on a pit coal in the Jiu Valley. Desulphurization of combustion gases and their general purification was a major problem in the last quarter of the century for many users of combustion installations with pollutant emissions.

Подведен итог измерениям, проведенным на пилотной установке по сжиганию в сжиженном слое, использовавшейся для проведения экспериментов в угольном разрезе Jiu Valley. Удаление серы и общая очистка газообразных продуктов сгорания являлась основной проблемой для многих пользователей установок по сжиганию с выбросом загрязняющих веществ в последней четверти прошлого века.

Experimental researches. I have done tests at the conditioned Jiu Valley pit coal combustion (H_i = 3800 kcal/kg = 15890 kJ/kg) in order to experiment noxes reduction solutions on a pilot combustion installation in liquefied layer. I have done measurements on a pilot installation using different reagents one by one (ammoniac, urea, calcar, sodium hydroxide etc.) to observe the emissions/concentrations reduction of the noxes from the emission gases (SO_2, CO, O_2, NO and NO_2). With the help of the TESTO 350 XL gasanalyst I have measured the pollutant emissions momentary and determined the atmospherical noxes concentrations by calculation (table 1), which can be compared to the limit admisible values (table 2).

The variation of the temperatures in the burning point and in the thermal transfer system, the variation of the temperatures when entering CGPS (Combustion Gases Purification System), the variations in the chimney after the centrifugal separator (cyclone) and CGPS have been monitored online with the help of the MENER program.

I have done reduction/retain pollutant tests through: ammoniac injection (NH_3 16 %, 1l/h ≈ 1, 6 g NH_3/Nm^3 gases); the insertion of urea granules into the burning point, mixed with the used fuel (about 150 g urea for 10 kg mineral coal 1,5 %); the gas wash in the reactor with alkaline solution (2-3 % NaOH, debit 1l solution/m^3 gases) the sulfur dioxide being retained simultaneously. At the entrance into the scrubber the gases are being wet by the washing liquid pulverized through a system mounted on the hood of the scrub, they are completely undusted; the retain into the liquid of some gas pollutants taking place also (SO_2 and NO_x).

The combustion gases have been analyzed in front of the scrub and after the drops separator (at the gas evacuation into the chimney).

These results (table 1) represent the measured values mediation during a long continuous functioning of the installation (several hours)*.

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Table 1

The experimental results on pit coal from Jiu Valley combustion on a pilot installation

	CO, mg/m³ N	NO_x, mg/m³ N	SO_2, mg/m³ N	CO_2, g/m³ N	CO*, mg/m³ N	NO_x*, mg/m³ N	SO_2*, mg/m³ N	CO_2*, mg/m³ N	T, °C	O_2, %	λ	Red. SO_2, %	Red. NO_x, %
The measurements results in front of the cyclone													
	185,00	681,43	4770,00	320,10	158,66	584,42	4090,91	274,54	246,3	3,51	1,06		
	430,00	494,65	4035,50	264,33	370,90	426,67	3480,88	228,01	261,9	3,61	1,32		
	163,75	562,39	3821,15	287,70	158,06	542,84	3688,36	277,71	273,1	5,46	1,23		
	118,75	533,65	4201,26	282,98	114,33	513,78	4044,86	272,46	287,3	5,42	1,36		
	122,50	611,65	5084,38	340,33	115,20	575,21	4781,55	320,07	288,9	5,05	1,02		
Average	204,00	576,75	4382,46	299,09	183,43	528,59	4017,31	274,55	271,50	4,61	1,20		
The measurements results after the cyclone													
	375,00	184,73	4775,72	153,18	632,22	311,33	8048,96	258,17	254	12,1	2,36		
	375,00	164,20	3958,33	153,18	632,22	276,74	6671,34	258,17	254,4	12,1	2,36		
	375,00	164,20	3786,85	153,18	632,22	276,74	6382,33	258,17	254,4	12,1	2,36		
	382,00	174,46	4195,54	151,21	636,67	290,77	6992,57	252,03	254,4	12	2,35		
	380,25	174,46	5055,80	151,21	633,42	290,77	8426,34	252,03	254,4	12	2,35		
Average	377,25	172,41	4354,44	152,392	633,55	289,27	7304,30	255,714	254,32	12,06	2,35		
The measurements results after the cyclone, with ammoniac injection													
	343,75	96,7	154,33	257,26	326,34	274,75	146,52	244,24	275	5,2	2,35	96,7	56,3
	233,75	96,1	151,47	274,93	202,67	298,98	131,34	238,39	187	3,7	1,38	96,1	49,9
	182,50	95,7	160,05	239,58	184,97	266,27	162,21	242,83	146	6,2	5,1	95,7	56,4
	170,00	95,3	194,34	239,58	187,50	260,34	214,35	264,25	136	7,4	6,9	95,3	53,9
	160,00	97,4	140,04	190,49	206,90	281,33	181,09	246,33	128	9,4	9,4	97,4	58,7
Average	218,00	96,30	160,05	240,37	221,68	276,33	167,10	247,21	174,4	6,38	5,02	96,30	55,04

* Related to O_{2ref}. Note: 1.

$$(CO, NO_x, SO_2, CO_2)^* = \frac{21 - O_{2ref}}{21 - O_{measured}} (CO, NO_x, SO_2, CO_2).$$

2. 1 ppm NO_x = 2,05 mg/m³ N; 1 ppm NO = 1,33 mg/m³ N; 1 ppm SO_2 = 2,85 mg/m³ N; 1 ppm CO = 1,25 mg/m³ N.

Table 2

The admissible limit values

Noxes	The maximum admissible concentration [mg/m^{3}N]			
	Short time average		Annual long term medium for the protection of:(*from 2010)	
	1 h	Daily	Human health	Vegetal health
SO_2	350	125	20	20
NO_x	200*	-	40*	30*
PM_{10}	–	50	40*	20*
CO	Average at 8 h daily 10 mg/m^{3}N			

Conclusions. During the experiment on the combustion on pit coal from Jiu Valley on the pilot installation in liquefied layer I was able to observe:

- after three hours of continuous functioning, the temperature when exiting the burning point equaled the one entering the convective part;
- the variation of the temperatures when entering the combustion gases purification system (CGPS) after the centrifugal separator (cyclone) and after CGPS at the chimney;
- the variation of the SO_2 pollutant concentration during 1,5 hours of measurements, before and after CGPS when using the (NH_3) ammoniac as a reductive agent;
- the variation of the NOx pollutant concentration during 1,5 hours of measurements, before and after CGPS when using NH_3 or urea as a reductive agent;
- a medium degree of reduction for NO_x and SO_2 during the experiments (in the first stage, the ammoniac was used for the reduction of the NO_x and SO_2 concentrations, in the second stage the ammoniac was used for the reduction of the SO_2 and the urea for the reduction of the NO_x).

For the denoxation and neutralization of the SO_2, as ammonium sulfur [$(NH_4)_2SO_4$], at the technologies that use (NH_3) the working costs are high (because of the reagents consume) but there is no used water resulting.*

After using the limestone as a reagent into the burning point I found that: the primary matter is inexpensive and the investment and working costs are much lower than in the case of using other combustion gases desulfurization processes; the desulfurization degree when burning the coal in liquefied layer is high and it ensures SO_x concentrations in the combustion gases inferior to the limit one; because of the high temperature the synthetization of the calcium oxides particles is produced or even the calcium sulfur decomposition; the quantity of ash that must be evacuated from the combustion installation is increased.

On the other hand the conditions for retaining the ashes dust into the electro filters are worse as a consequence of the increased particles' finesse, but most of all as a consequence of their electric resistivity increased because of the increased sulfur content retained into the ashes.

The uses of absorbents in the combustion systems in liquefied layer constitute integrated desulfurization systems. These limit the combustion temperature around 850 °C; the maximum value reached in short periods has been of 1200 °C.

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