

CERTIFICATES OF COAL

VORKUTAUGOL

RUSSIA

Pechorskaya coking coal (grade 2ZH)

Brand: Hard coking coal (2ZH), HV
Production: Vorkutaugol (Russia), TSOE Pechorskaya

Proximate and other analyses		As received	Dry	Dry ash free
Total moisture	%	7,0		
Ash	%	8,1	8,7	
Volatile matter	%	28,5	30,5	33,0
Total Sulphur	%	0,56	0,60	
Fixed carbon	%		62,4	
Phosphorus	%		0,025	
Chlorine	%		0,030	
Net Calorific Value BTU	Kkal/kg	7000		
Carbonization analyses		Ultimate analysis (%) Dry ash free		
Free swelling index (FSI)		8	Carbon	86,7
Gray-King coke type		G9	Hydrogen	5,3
Roga Index		58	Nitrogen	2,5
<u>Audibert-Arnu dilatometer:</u>			Oxygen	4,9
Initial softening temp.	°C	376	Sulphur	0,6
Maximum contraction temp.	°C	413	Ash analysis (%) Dry	
Maximum dilatation temp.	°C	472	SiO ₂	58,60
Contraction.	%	23	Al ₂ O ₃	21,50
Dilatation	%	90	Fe ₂ O ₃	7,80
<u>Gieseler plastometer:</u>			CaO	2,82
Initial softening temp.	°C	377	MgO	1,72
Maximum fluidity temp.	°C	436	Mn ₃ O ₄	0,18
Solidification temp.	°C	471	K ₂ O	2,46
Maximum fluidity	ddpm	1389	Na ₂ O	0,46
<u>Plastometry by method Sapozhnicova</u>			TiO ₂	1,46
Plastic layer	mm	19	P ₂ O ₅	0,44
Contraction	mm	23	SO ₃	1,43
Petrographic analysis		As analysed	Alkali in coal (%) Dry	
Rank Index	%	III	K ₂ O	0,155
Vitrinite reflectance (Ro average)	%	1,02	Na ₂ O	0,125
<u>Vitrinite distribution (V-type)</u>			Ash Fusion Temperature (°C)	
0,75-0,84	%	1,0	Initial deformation temp.	1410
0,84-0,99	%	35,0	Softening temp.	1425
1,00-1,14	%	42,0	Hemispherical temp.	1440
1,15-1,30	%	12,0	Fluid temp.	1480
1,31-1,49	%	9,0	Sizing (mm) %	
1,50-1,74	%	1,0	0-1	59,7
		Dry ash free	1-13	34,7
<u>Total Reactives</u>	%	83,0	13-25	4,7
Vitrinites	%	78	25-50	0,6
Semivitrinites	%	1,0	50-100	0,2
Liptinites	%	4,0	Mean size (mm)	0 – 100
<u>Total Inerts</u>	%	17,0	Sulphur Forms	
Inertinites	%	15,0	Pyrite	0,13
Semivitrinites	%	2,0	Sulphate	0,01
Coke Indices				
Relative Degree of Oxidation	%	97	Micum M40	70
Wall pressure (psi)	psi	0,4	Micum M10	9,8
Hardgrove grindability index (HGI)		68	CSR	54

Severnaya coking coal (grade 2ZH)

Brand: Hard coking coal (2ZH)
Production: Vorkutaugol (Russia), OF Severmaya

Proximate and other analyses		As received	Dry	Dry ash free
Total moisture	%	8,0		
Ash	%	7,9	8,5	
Volatile matter	%	28,5	30,5	33,0
Total Sulphur	%	0,56	0,60	
Fixed carbon	%		62,4	
Phosphorus	%		0,010	
Chlorine	%		0,037	
Net Calorific Value	Kkal/kg	7100		
BTU				
Carbonization analyses		Ultimate analysis (%)		
Free swelling index (FSI)		7,5	Carbon	86,9
Gray-King coke type		G8	Hydrogen	5,8
Roga Index		63	Nitrogen	2,2
<u>Audibert-Arnu dilatometer:</u>			Oxygen	4,6
Initial softening temp.	°C	359	Sulphur	0,5
Maximum contraction temp.	°C	400		
Maximum dilatation temp.	°C	467	Ash analysis (%)	
Contraction.	%	31		Dry
Dilatation	%	154	SiO ₂	58,66
<u>Gieseler plastometer:</u>			Al ₂ O ₃	22,05
Initial softening temp.	°C	375	Fe ₂ O ₃	8,04
Maximum fluidity temp.	°C	428	CaO	2,96
Solidification temp.	°C	471	MgO	1,92
Maximum fluidity	ddpm	10 000	Mn ₃ O ₄	0,03
<u>Plastometry by method Sapozhnicova</u>			K ₂ O	0,73
Plastic layer	mm	19	Na ₂ O	0,77
Contraction	mm	23	TiO ₂	1,37
			P ₂ O ₅	0,19
			SO ₃	2,92
Petrographic analysis		As analysed	Alkali in coal (%)	
Rank Index	%	III	K ₂ O	0,118
Vitrinite reflectance (Ro average)	%	1,01	Na ₂ O	0,093
<u>Vitrinite distribution (V-type)</u>			Ash Fusion Temperature (°C)	
0,75-0,84	%	-	Initial deformation temp.	1410
0,84-0,99	%	12,0	Softening temp.	1445
1,00-1,14	%	78,0	Hemispherical temp.	1455
1,15-1,30	%	10,0	Fluid temp.	1480
1,31-1,49	%	-	Sizing (mm)	
1,50-1,74	%	-		%
<u>Total Reactives</u>	%	Dry ash free	0-1	12,2
Vitrinites	%	70,0	1-13	58,2
Semivitrinites	%	67	13-25	18,6
Liptinites	%	1,0	25-50	7,8
<u>Total Inerts</u>	%	30,0	50-100	3,2
Inertinites	%	27,0	Mean size (mm)	0 – 100
Semivitrinites	%	3,0	Sulphur Forms	
			Pyrite	0,03
			Sulphate	0,26
Coke Indices (Pilot Coke Oven Tests)				
Relative Degree of Oxidation	%	97	Micum M40	72
Wall pressure (psi)	psi	0,38	Micum M10	9,6
Hardgrove grindability index (HGI)		66	CSR	55

Pechorskaya coking coal (grade K)

Brand: Hard coking coal (K), MV
 Production: Vorkutaugol (Russia), TSOE Pechorskaya

Proximate and other analyses		As received	Dry	Dry ash free
Total moisture	%	7,0		
Ash	%	8,8	9,5	
Volatile matter	%	22,7	24,4	27,0
Total Sulphur	%	0,65	0,70	
Fixed carbon	%		70,0	
Phosphorus	%		0,018	
Chlorine	%		0,020	
Net Calorific Value BTU	Kkal/kg	7000		
Carbonization analyses		Ultimate analysis (%) Dry ash free		
Free swelling index (FSI)		9,0	Carbon	88,7
Gray-King coke type		G8	Hydrogen	5,2
Roga Index		62	Nitrogen	2,4
<u>Audibert-Arnu dilatometer:</u>			Oxygen	3,1
Initial softening temp.	°C	-	Sulphur	0,6
Maximum contraction temp.	°C	-	Ash analysis (%) Dry	
Maximum dilatation temp.	°C	-	SiO ₂	-
Contraction.	%	-	Al ₂ O ₃	-
Dilatation	%	80	Fe ₂ O ₃	-
<u>Gieseler plastometer:</u>			CaO	-
Initial softening temp.	°C	-	MgO	-
Maximum fluidity temp.	°C	-	Mn ₃ O ₄	-
Solidification temp.	°C	-	K ₂ O	2,00
Maximum fluidity	ddpm	200	Na ₂ O	1,10
<u>Plastometry by method Sapozhnicova</u>			TiO ₂	-
Plastic layer	mm	17	P ₂ O ₅	-
Contraction	mm	19	SO ₃	-
Petrographic analysis		As analysed	Alkali in coal (%) Dry	
Rank Index	%	III-IV	K ₂ O	0,140
Vitrinite reflectance (Ro average)	%	1,20	Na ₂ O	0,050
<u>Vitrinite distribution (V-type)</u>			Ash Fusion Temperature (°C)	
0,75-0,84	%	-	Initial deformation temp.	-
0,84-0,99	%	-	Softening temp.	-
1,00-1,14	%	25,0	Hemispherical temp.	-
1,15-1,30	%	65,0	Fluid temp.	-
1,31-1,49	%	10,0	Sizing (mm) %	
1,50-1,74	%	-	0-1	52,5
		Dry ash free	1-13	38,3
<u>Total Reactives</u>	%	75,0	13-25	6,7
Vitrinites	%	72	25-50	1,7
Semivitrinites	%	3,0	50-100	0,8
Liptinites	%	2,0	Mean size (mm)	0 – 100
<u>Total Inerts</u>	%	25,0	Sulphur Forms	
Inertinites	%	20,0	Pyrite	0,03
Semivitrinites	%	5,0	Sulphate	0,26
Coke Indices				
Relative Degree of Oxidation	%	98	Micum M40	72
Wall pressure (psi)	psi	-	Micum M10	9,0
Hardgrove grindability index (HGI)		72	CSR	58

Pechorskaya coking coal (grade GZHO)

Brand: Semi-soft coking coal (GZHO), HV
 Production: Vorkutaugol (Russia), TSOE Pechorskaya

Proximate and other analyses		As received	Dry	Dry ash free
Total moisture	%	7,5		
Ash	%	8,3	9,0	
Volatile matter	%	31,2	33,7	37,0
Total Sulphur	%	1,38	1,45	
Fixed carbon	%		60,0	
Phosphorus	%		0,008	
Chlorine	%		0,035	
Net Calorific Value BTU	Kkal/kg	6700		
Carbonization analyses		Ultimate analysis (%) Dry ash free		
Free swelling index (FSI)		3,0	Carbon	82,7
Gray-King coke type		G1	Hydrogen	5,5
Roga Index		15	Nitrogen	2,6
<u>Audibert-Arnu dilatometer:</u>			Oxygen	7,7
Initial softening temp.	°C	401	Sulphur	1,5
Maximum contraction temp.	°C	495	Ash analysis (%) Dry	
Maximum dilatation temp.	°C	-	SiO ₂	57,39
Contraction.	%	-20	Al ₂ O ₃	18,42
Dilatation	%	-	Fe ₂ O ₃	11,75
<u>Gieseler plastometer:</u>			CaO	2,90
Initial softening temp.	°C	401	MgO	2,35
Maximum fluidity temp.	°C	428	Mn ₃ O ₄	0,05
Solidification temp.	°C	440	K ₂ O	1,76
Maximum fluidity	ddpm	6	Na ₂ O	1,06
<u>Plastometry by method Sapozhnicova</u>			TiO ₂	1,20
Plastic layer	mm	12	P ₂ O ₅	0,11
Contraction	mm	40	SO ₃	1,60
Petrographic analysis		As analysed	Alkali in coal (%) Dry	
Rank Index	%	II	K ₂ O	0,139
Vitrinite reflectance (Ro average)	%	0,82	Na ₂ O	0,078
<u>Vitrinite distribution (V-type)</u>			Ash Fusion Temperature (°C)	
0,65-0,74	%	11,0	Initial deformation temp.	1325
0,75-0,84	%	38,0	Softening temp.	1370
0,85-0,99	%	49,0	Hemispherical temp.	1390
1,00-1,146	%	2,0	Fluid temp.	1440
1,15-1,29	%	-	Sizing (mm) %	
1,30-1,40	%	-	0-1	38,2
		Dry ash free	1-13	45,7
<u>Total Reactives</u>	%	74,0	13-25	9,2
Vitrinites	%	68,0	25-50	4,7
Semivitrinites	%	1,0	50-100	2,2
Liptinites	%	5,0	Mean size (mm)	0 – 100
<u>Total Inerts</u>	%	26,0	Sulphur Forms	
Inertinites	%	23,0	Pyrite	0,33
Semivitrinites	%	3,0	Sulphate	0,01
Coke Indices				
Relative Degree of Oxidation	%	97	Micum M40	58
Wall pressure (psi)	psi	-	Micum M10	11
Hardgrove grindability index (HGI)		66	CSR	32

Steam coal GZHO (screen size 0-50)

Brand: Steam coal GZHO (screen size)

Production: Vorkutaugol (Russia), Vorgashorskaya mine

Proximate and other analyses		As received	Dry	Dry ash free
Total moisture	%	8,0		
Ash	%	21,9	23,8	
Volatile matter	%	25,6	27,8	36,5
Total Sulphur	%	1,80	1,95	
Fixed carbon	%		60,0	
Phosphorus	%		0,014	
Chlorine	%		0,020	
Net Calorific Value BTU	Kkal/kg	6700		
Carbonization analyses			Ultimate analysis (%)	
Free swelling index (FSI)		-	Carbon	82,7
Gray-King coke type		-	Hydrogen	5,5
Roga Index		-	Nitrogen	2,6
<u>Audibert-Arnu dilatometer:</u>			Oxygen	7,7
Initial softening temp.	°C	-	Sulphur	1,5
Maximum contraction temp.	°C	-		
Maximum dilatation temp.	°C	-	Ash analysis (%)	
Contraction.	%	-		Dry
Dilatation	%	-	SiO ₂	-
<u>Gieseler plastometer:</u>			Al ₂ O ₃	-
Initial softening temp.	°C	-	Fe ₂ O ₃	-
Maximum fluidity temp.	°C	-	CaO	-
Solidification temp.	°C	-	MgO	-
Maximum fluidity	ddpm	-	Mn ₃ O ₄	-
			K ₂ O	2,60
<u>Plastometry by method Sapozhnicova</u>			Na ₂ O	1,35
Plastic layer	mm	12	TiO ₂	-
Contraction	mm	40	P ₂ O ₅	-
			SO ₃	-
			Alkali in coal (%)	
				Dry
Petrographic analysis		As analysed	K ₂ O	0,58
Rank Index	%	II	Na ₂ O	0,30
Vitrinite reflectance (Ro average)	%	0,82	Ash Fusion Temperature (°C)	
<u>Vitrinite distribution (V-type)</u>			Initial deformation temp.	1320
0,65-0,74	%	-	Softening temp.	1365
0,75-0,84	%	-	Hemispherical temp.	1380
0,85-0,99	%	-	Fluid temp.	1430
1,00-1,146	%	-	Sizing (mm)	
1,15-1,29	%	-		%
1,30-1,40	%	-	0-1	12,6
			1-13	50,4
<u>Total Reactives</u>	%	Dry ash free	13-25	21,8
Vitrinites	%	-	25-50	11,0
Semivitrinites	%	-	50-100	4,2
Liptinites	%	-	Mean size (mm)	0 – 50
<u>Total Inerts</u>	%	-	Sulphur Forms	
Inertinites	%	-	Pyrite	0,35
Semivitrinites	%	-	Sulphate	0,01
Coke Indices				
Relative Degree of Oxidation	%	97	Micum M40	-
Wall pressure (psi)	psi	-	Micum M10	-
Hardgrove grindability index (HGI)		65	CSR	-