

Estimation of the Number of Underground coal Miners and Normalization Collective Dose at Present in China

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Introduction

Classifications of coal mines and annual outputs

Estimation of underground coal miner

Estimation of collective dose

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Introduction



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- **China collective dose is a part of worldwide**
- **The number of underground coal miner was estimated before 2004 based on annual output and production efficiency of raw coal**
- **the development of coal production technology and the adjustment of energy industrial structure**
- **In order to estimate the collective dose and the normalization collective dose countrywide**

Classifications and annual outputs



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Three kinds of coal mines

- ✓ the national key coal mines (NKCM)
- ✓ state-owned local coal mines (SLCM)
- ✓ township and private-ship coal mines (TPCM)

Classifications and annual outputs



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years	total	NKCM	SLCM	TPCM	NKCM rate	SLCM rate	TPCM rate	origin
2005	1997.35	938.80	296.80	761.75	47.00	14.86	38.14	CCGA,2006
2006	2331.78	1119.56	319.85	892.37	48.00	13.72	38.28	CCGA,2007
2007	2523.41	1214.91	338.45	970.05	49.22	13.42	37.36	CCGA,2008
2008	2748.57	1377.81	349.71	1021.05	50.12	12.72	37.16	CCGA,2009
2009	3012.51	1526.34	394.26	1091.91	50.67	11.36	37.97	CCGA,2010
2010	3249.39	1881.39	662.88	705.12	57.90	20.40	21.70	CCGA,2011
2011	3616.60	2141.80	529.00	945.80	59.20	14.60	26.20	CCGA,2012
2012	3650.00	2365.20	682.60	602.20	64.80	18.70	16.50	CCGA,2013
2013	3969.00	2579.9	754.1	635.0	65.00	19.00	16.00	CCGA,2014
2014	3870.00	2627.7	793.35	503.10	66.50	20.50	13.00	Jiang Zhimin, 2015

Estimation of miner



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Method

$$N = \sum_{i=1}^3 M_i = \sum_{i=1}^3 \frac{P_i}{K_i \times D_i}$$

Estimation of miner



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The regulation on the two-day-relaxation each week was widely adopted in the NKCM and in the SLCM, which added up to 104-106 days in a year, and the legal holidays were 10 days, there were **about 250 working days for a worker in a year.**

But in the TPCM, the employees hardly enjoyed the two-day-relaxation, so it was estimated about **300 working days for a worker within a year.**

the output of open air coal mine accounts for 5%-8% of total output countrywide by calculating result the typical ratio value of underground output **is 95% to total output for each type of coal mines** by adopting suggestion of exports of coal institute.

Estimation of miner



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years	NKCM			SLCM			TPCM			Y
	Y1	Y2	Y3	Y1	Y2	Y3	Y1	Y2	Y3	Y4
2005	891.86	4.109	868202	281.96	1.182	954179	723.66	0.894	2698210	4520591
2006	1063.58	4.434	959477	303.86	1.331	913178	847.75	0.915	3088342	4960997
2007	1154.17	4.57	1010214	321.53	1.48	869000	921.55	0.935	3285383	5164598
2008	1308.92	4.987	1049865	332.22	1.629	815764	970.00	0.956	3382148	5247777
2009	1450.02	5.326	1089012	374.55	1.778	842632	1037.31	0.978	3535481	5467125
A1	1173.70	4.685	995354	322.82	1.48	878951	900.05	0.936	3197913	5072217
T1	1200	4.685	1.0×10^6	320	1.480	9.0×10^5	900	0.936	3.6×10^6	5.1×10^6

Estimation of miner



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years	NKCM			SLCM			TPCM			Y4
	Y1	Y2	Y3	Y1	Y2	Y3	Y1	Y2	Y3	
2010	1787.32	5.664	1262232	629.74	1.927	1307184	669.86	0.985	2266883	4836299
2011	2034.71	6.232	1305976	502.55	2.076	968304	898.51	1.013	2956598	5230877
2012	2246.94	6.437	1396265	648.47	2.225	1165789	572.09	1.049	1817890	4379944
2013	2450.91	6.952	1410187	716.40	2.374	1207068	603.25	1.052	1911439	4528694
2014	2496.32	7.233	1380514	753.68	2.523	1194899	477.95	1.075	1482000	4057413
A2	2203.24	6.504	1351035	650.17	2.225	1168649	644.33	1.035	2086962	4606646
T2	2200	6.504	1.4×10 ⁶	650	2.225	1.2×10 ⁶	645	1.035	2.1×10 ⁶	4.7×10 ⁶

Collective dose



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Method

$$E = 9 \times 10^{-6} \times T \times C_{Rn} \times F$$

$$H_t = E \times N$$

$$H_n = H_t / Y_o$$

Collective dose



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KF606 radon accumulated detector (KF606-RAD) was used for measurement of radon concentration and γ radiation level, with Japan manufactured CR-39 solid nuclear track detector as radon detection element and LiF (Mg,Cu,P) TLDs made in China as γ ray detection element.

Measurements of radon concentration and γ radiation level were carried out by using KF606-RADs, and all the read out of tracks was finished only by the experts from the Beijing Research Institute of Chemical Engineering and Metallurgy (BRICEM).

Collective dose



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Rn Con. Of kind of coal mines

Type of mines	Measurement		Measurement and literatures		Conservative value recommended
	Range	Average	Range	Average	
NKCM	18~65	47	18~202	77	50
SLCM	22~1963	211	22~1963	189	100
TPCM	14~3115	631	14~3115	536	500
Bone coal	136~4183	1244	136~23976	5997	1500

Collective dose



type of coal mine	E (mSv/y)	N (10 ⁴ man) /Y _o (Mt)		H _T (man•Sv/y)		H _n (men•Sv/10 ⁴ t)	
		2005~2009	2010~2014	2005~2009	2010~2014	2005~2009	2010~2014
NKCM	0.28	100/1140	140/2185	280	392	0.0025	0.0018
SLCM	0.55	90/323	120/646	495	660	0.015	0.010
TPCM	3.3	320/903	210/646	10560	6930	0.117	0.107
合计		510/2366	470/3477	11335	7982	0.1345	0.1188

Conclusion



- First, the annual output of the NKCM increases from 35.7% in 2005 to 66.5% in 2014, and the percent of output of TPCM is decreasing from 38% in 2005 to 16% in 2013.
- The typical value of the underground coal miners recommended in China is 5.1 million in 2005~2009, and in which there are included 1 million, 0.9 million, and 3.2 million for NKCM, SLCM, TPCM, respectively. There are total 4.7 million underground coal miner in 2010~2014, and 1.4 million, 1.2 million, and 2.1 million for NKCM, SLCM, TPCM, respectively.

Conclusion



- The collective dose in 2005~2009 is 11335man•Sv, and in which there are included 280, 495, 10560 man•Sv for NKCM, SLCM, TPCM, respectively, of which the TPCM contribute about 93% of the total collective dose. As far as that of in 2010~2014, there are total 7982man•Sv, and 392, 660, 6930 man•Sv for each class coal mine.
- The normalization collective dose in 2005~2009 is 0.0025, 0.015, 0.117 man•Sv per 10kt for NKCM, SLCM, TPCM, respectively. As far as 2010~2014, there is 0.0018, 0.010, 0.107 man•Sv per 10kt for each class coal mine. The trend of normalization collective dose is decrease with year increase.



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Thank you cooperation !

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