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Specifications for coalbed methane resources / reserves

煤层气资源/储量规范

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Specifications

for coalbed methane resources / reserves

1 Scope

This Standard specifies the classification and grading standard, definitions, reserves calculation methods, reserves evaluation standard, and preparation requirements for reserves report of China's coalbed methane resources / reserves.

This Standard is applicable to the ground-drill-development's mine's coalbed methane resources / reserves calculation; it is applicable to coalbed methane resources exploration, reserves calculation, development and design, and report preparation. It may be used as basis for the coalbed methane resources / reserves ownership transfer, securities trading, reserves assessment in other public service and commercial mining activities.

2 Normative references

The following standards contain the provisions which, through reference in this Standard, constitute the provisions of this Standard. For dated references, subsequent amendments (excluding corrections) or revisions do not apply to this Standard. However, the parties who enter into agreement based on this Standard are encouraged to investigate whether the latest versions of these documents are applicable. For undated reference documents, the latest versions apply to this Standard.

GB 212-91 Proximate analysis of coal

GBn/T 270-88 Natural gas reserves specification

GB/T 13610-92 Analysis of natural gas by gas chromatography

Reserves-Release [1986] No. 147 Specification of geological exploration of coal resources

MT/T 77-94 Determination method of coalbed methane (desorption)

3 General provisions

3.1 The coalbed methane field (reserves) reservoir is heterogeneous. There exists the differences in gas content and capacity etc. It shall be appropriate to carry out rolling exploration-development. It shall conduct dynamic reserves assessment. From discovery to abandoned stages of exploration and development, its operator shall - according to geological changes, changes in engineering data, technical and economic conditions or policies - conduct reserves evaluation, calculation, double-calculation, and business accounting in phrases.

3.2 Coalbed is the reservoir for coalbed methane. Coal field exploration and awareness degree is not only an important foundation for coalbed methane exploration deployment, but also an important basis for coalbed methane resources / reserves evaluation.

4 Definitions

4.1 Coalbed methane

The hydrocarbon gas of which the main component is methane; it is mainly absorbed to the particle surface of the coal matrix, and is partially dissociated in pores or dissolved in coalbed water.

4.2 Coalbed methane resources

4.2.1 Definition

Coalbed methane concentration that takes underground coal as reservoir and has economic significance. The amount is represented as resources amount or reserves amount.

4.2.2 Coalbed methane resources

The total amount of coalbed methane which is occurred in coalbed, according to the estimation by certain geological and exploration engineering basis; is recoverable in current time or future; and has the realistic economic significance and potential economic significance.

4.2.3 Original coalbed methane in place of coalbed methane

4.2.3.1 Definition

4.3.3 Exploration

It refers to the actual implementation phase of coalbed methane exploration when implementing the project of coalbed methane exploration in the evaluation selection to obtain the awareness on the nature of coal and gas content by parameter-well or geophysical engineering, so as to obtain coalbed methane's capacity and well optimization parameters under technical conditions by single-well and/or small well-network development tests. Coalbed methane reserves can be calculated according to exploration results.

4.4 Coalbed methane development

It refers to formal mining activities of coalbed methane resources according to certain developing plans and deployment of development well-network with certain well spacing in the exploration area. Coalbed methane is generally suitable for rolling exploration and development.

5 Classification and grading of coalbed methane resources / reserves

5.1 Classification and grading principles

The classification of coalbed methane resources / reserves is determined by economic benefits yielded by production and sales in certain policies, laws, time and environmental conditions. Based on the economic feasibility, it is divided into 3 categories - commercial, sub-commercial, and intrinsic commercial. economic evaluation of the project. The classification shall be based on the principle of geological understanding level of coalbed methane resources. Based on exploration and development projects, level of geological knowledge, it is divided into 2 grades – discovered and to be discovered. The discovered coalbed methane resources, also known as coalbed methane geological reserves, is divided into 3 grades – predicted, controlled and proved, based on geological confidence. The appropriate grades of recoverable reserves can be determined according to the geological reserves.

5.2 Classification

5.2.1 Commercial

In the current economic and technical conditions, production and sales of coalbed methane are technically feasible, economically reasonable

has verified the coalbed methane resources and recoverability in the exploration scope. The confidence level of coalbed methane resources is high. Confidence coefficient of reserves is 0.7-0.9.

The classification and grading of remainder proved initial reserves may refer to the "Natural gas reserves specification". It is not named temporarily in this Standard. Remainder proved initial reserves can be divided into two categories – developed and to be developed, based on developing status:

- a) Developed: the number of coalbed methane that is expected to be explored from existing wells within the proved area;
- b) To be developed: the number of coalbed methane that is expected to be explored from undrilled well area or another reservoir deepened from the existing well within the proved area.

5.4 Classification and grading system of coalbed methane resources / reserves

Set up the classification and grading system of coalbed methane resources / reserves (Table 1), according to the standards of classification and grading of coalbed methane resources / reserves as well as its relation with exploration control engineering.

	pressure, and other information have been obtained by experiments and tests.	control degree.	information has been obtained.
	Small-scale well-network exploration test and / or single-well trial exploration have been carried out for gas reservoirs. When gas reservoir's geological conditions are consistent, it may use the trial exploration or production achievements of neighboring area. Through trial exploration, it has obtained gas well pressure, gas production, water production, variation pattern with time, and other reliable information. Well spacing of trial exploration well shall not exceed 2 times of predetermined distance in Appendix B.	It has conducted single-well trial exploration in representative site to obtain gas well pressure, gas production, water production, variation pattern with time, and other relevant information.	
Awareness degree	The structural configuration of coalbed is clear. Coalbed thickness, metamorphic grade and other distribution changes are clear. The scale of submitted reserve calculation scale map is not less than 1: 25,000. The research on reserves parameters is deep. The selected values are reliable. After trial exploration, it has obtained the production curve and gas-well capacity awareness. It has conducted the development conceptual design, numerical simulation, and economic evaluation. The development is commercial.	The structural configuration of coalbed is clear. Coalbed thickness, burial depth, metamorphic grade, gas content, permeability, gas saturation and other distribution changes are clear. The scale of submitted reserve calculation scale map is not less than 1: 50,000. The research on reserves parameters is deep. The selected values are reliable. . After trial exploration, it has obtained the production curve and gas-well capacity awareness. It has conducted preliminary economic evaluation or development evaluation. The development is commercial or sub-commercial.	It has preliminarily understood coalbed structural shape, thickness, metamorphic grade, gas content and other distribution changes. The scale of submitted reserve calculation scale map is not less than 1: 100,000. It has preliminarily confirmed the reserves parameters by reasonable speculation of coal field drill-holes or small amount of parameter-wells. The trial exploration is not conducted, gas well production is obtained by analogy. It only carries out geological evaluation and preliminary economic evaluation. There is commercial value for the development.

6.1.2 Reserves calculation unit

Reserves calculation unit is usually the coalbed methane reservoir, i.e., the coal reservoir collection that contains gas and is controlled by various geological factors. When there is no clear geological boundary for coalbed methane reservoir, calculate according to calculation boundary of coalbed methane reservoir. Calculation unit is usually called “area-block” on plane. A very-large area-block can be subdivided into well-blocks (or well-areas). A same area-block shall has the same or similar structural conditions and reservoir conditions etc. The single coalbed is generally used as calculation unit longitudinally. For coalbed group of which the coalbeds are relatively concentrated, the calculation units can be merged. The reserves of shallow coal reservoir in coalbed weathered zone shall not be calculated. The indicators of weathered zone shall refer to “Specification of geological exploration of coal resources”.

6.1.3 Reserves calculation boundary

The boundary of reserves calculation unit shall be preferably determined according to the ascertained various geological boundaries, such as fault, stratum changes (thinning, thinning-off, erosion, metamorphism, etc.), lower limit of gas content, lower limit of net thickness of coalbed (0.5-0.8m), etc. (It may appropriately adjust according to the actual conditions of coalbed group). If the geological boundaries failed to be found out, they were mainly determined by the coalbed methane’s gas-well that reaches the lower limit of capacity. Due to various reasons, it may also be determined by mining right district boundaries, natural geographic boundaries, or the calculation line of reasonable extrapolated well control reserves, etc. The lower limit of coalbed’s gas content is shown in Table 4. Table 4 can also be adjusted by demonstrating according to the specific conditions. When the thickness of coalbeds is different, it shall be appropriately adjusted.

Table 4 Lower limit standard of coalbed’s gas content

Coal types	Degree of metamorphism ($R_{o,max}$) %	Gas content of air dried basis m^3/t
Brown coal - long flame coal	<0.7	1
Gas coal - lean coal	0.7~1.9	4
Meagre coal - anthracite	>1.9	8

6.2 Reserves calculation method

6.2.1 Original coalbed methane in place calculation

6.2.1.1 Analogy method

It mainly uses the relation with developed coalbed methane (or similar reservoir) to calculate the reserves. When calculating, the typical curves related to production characteristics and reserves correlation of developed area shall be drawn. Obtain the reserves parameters in calculation area. Then combine with other methods to calculate the reserves. The analogy method can be used for calculating the predicted geological reserves.

6.2.1.2 Volumetric method

parameters - fundamental geology, reservoir physical property, reservoir fluidity, and production dynamic. The reservoir geological model used for capacity forecast can be set up through the description of these parameters.

- c) History-matching and capacity forecast: The stratum simulation tools are used for calculating the obtained reservoir geological and engineering parameters. The calculated gas, water production, and pressure value are history-matched with actual production value and actual-measured pressure value of the gas-well. When the simulated gas and water production performance is match-fitted with the actual production performance of the gas-well, a gas reservoir model can be set up, so as to obtain a gas production curve, to forecast the methane production in the future. And obtain the final cumulative coalbed methane production, that is, the recoverable reserves of the coalbed methane.

According to the mastery degree and calculation accuracy of the information, the calculated results of reservoir simulation method can be used to control the recoverable reserves and proved recoverable reserves.

6.2.2.2 Production decline method

Production decline method refers to the method that forecasts the reserves by studying the coalbed gas-well's production characteristics such as gas production rules, analyzing the gas-well's exploitation characteristics and historical information. Generally, it is after the coalbed methane well's production goes through its gas-production peak; starts stable-production or start to decline. It utilizes the slope of the production decline curve to calculate the future production. Production decline method is actually the coalbed methane well production characteristics extrapolation method. The following conditions shall be satisfied before using production decline method:

- a) There is a reason to believe that the selected production curve is of typical representative significance of gas reservoir's gas production;
- b) Gas production area of gas-wells can be clearly defined;
- c) On yield-time curve, there are at least half-year or longer stable gas production decline curve slope value after gas production peak;
- d) It must effectively eliminate the influences of production changes to the decline curve slope value, which is caused by non-geological factors such as market shrinkage, well repair, and surface water treatment.

Production decline method can be used to calculate the proved recoverable reserves, especially in the development phase when gas-wells are put into production. Production decline method can be combined with volumetric method and stratum simulation method to improve reserves calculation accuracy.

production, if the inter-well distance between 2 adjacent wells exceeds 2-times well-spacing, but it is less than 3-times well-spacing, all inter-well area is considered as proved area. At the same time, taking the 2 wells as the center, extrapolate 1 well-spacing as 他和 boundary of the proved area.

- 4) In case that multiple adjacent wells reach the lower limit value of gas production and all the inter-well distance are not greater than 2 well-spacing. The **boundary** of proved area boundaries can be drawn by extrapolating 1 well-spacing, taking the peripheral well as center.
- c) **Due to various reasons, it may also be** delineated by mineral rights area boundaries, physical geography boundaries or man-made reserves calculation-line etc. The distance BETWEEN proved area boundary AND coalbed methane gas-well shall not be greater than 0.5-1.0 times well-spacing as specified in Appendix B.

7.1.2 **Effective** (net) thickness of coalbed (abbreviated as effective thickness or net thickness)

Effective coalbed thickness refers to true coalbed thickness deducting gangue layer thickness. It is also known as **net** thickness. Proved net thickness shall be determined by the following principles:

- a) It shall be confirmed to have reached the initial-calculation standard through trial production of coalbed methane well. Coalbed that has not been conducted for trial production shall be **continuous** or similar to the adjacent wells of which the coalbed has reached initial-calculation standard;
- b) **Well (borehole) control degree shall meet requirements of well spacing in Appendix B. Usually, area weighing method shall be adopted.**
- c) **Effective thickness shall be mainly determined by drilling coring or logging delineation. When well-oblique is too large, it shall correct well's position and thickness.**
- d) **The lower limit of single-well effective thickness of coalbed is 0.5 m-0.8 m (it can be adjusted depending on the gas content). The thickness of the gangue layer is 0.05 m-0.10m.**

7.1.3 Coal mass density

Coal mass density is divided into true coal mass density and apparent coal mass density. It corresponds to different gas content datum in reserves calculation. **Determination methods are shown in GB/T 212-91 "Proximate analysis of coal".**

7.1.4 Coalbed's gas contents

It may adopt the following 2 gas contents datum - "dry, ash-free basis" or "air-

B, area weighing method shall generally be used to take a value. For the contour-line that is circled by calibration-well and is larger than the adjacent coalbed methane well, the exceeding gas content value will not be taken into account for weighing.

- b) When calculating unproved reserves, it shall adopt the measured gas content of live coal direct desorption and coal exploration coal-core analysis (Coal industry standard MT/T 77-94). The gas content is obtained by analogy with adjacent area of similar geological conditions and coal quality; it can be used for the calculation of predicted geological reserves. When necessary, gas content can be estimated according to coal quality and depth. The estimated gas content may be used in the calculation of predicted geological reserves.
- c) Mine relative gas emission shall be used as a reference for calculation of inferred resource reserves after comprehensively analyzing geological environment and tectonic conditions of coalbed, roof-floor plate, adjacent layer, worked out section. Although isothermal adsorption curve used for gas outburst prevention can also provide coalbed theoretical gas content, but it shall conduct correction of moisture, temperature and other aspects when it is used as a reference. After calibration, it may be used for calculation of speculated resources.
- d) Coalbed methane composition determination shall be executed in accordance with GB/T 13610-92 "Analysis of natural gas by gas chromatography". Coalbed methane reserves shall be calculated in accordance with different type of gas composition. Under normal circumstances, coalbed's gas content's measured values involved in reserves calculation shall exclude those non-hydrocarbon gas compositions of which the concentration exceeds 10%.

7.2 Determination of parameters of numerical simulation method and production decline method

Parameters of numerical simulation method and production decline method, such as gas composition, coal property and components, reservoir physical property, isothermal adsorption characteristics, temperature, pressure, gas-water production etc. shall be executed by reference to GB 212-91, GB/T 13610-92 and relevant standards. or otherwise formulate the detailed-rules.

7.3 Parameters values of reserves calculation

- a) The parameter in reserves calculation can be obtained by various information and methods. Its accuracy and representativeness shall be in-detail compared by a comprehensive value-selection when in selection. And discuss the basis of parameter determination in the reserves report;
- b) When calculating the parameters' average value of geological unit, in principle, the thickness of coalbed shall be based on actual construction-development regular-pattern, and adopt the contour-line area weighing

Appendix A

(Normative)

Provisions of coalbed methane reserves calculation's parameter names, units, symbols, and valuing significant digits

Table A.1 Provisions of coalbed methane reserves calculation's parameter names, units, symbols, and valuing significant digits

Parameter		Unit		The value of significant digit
Name	Symbol	Name	Symbol	
Gas-containing area of coalbed	A	Square kilometers	km^2	1 decimal place
Ash content of coal (W_B)	A_d	Zero dimension	%	2 decimal places
Average ash content of coal	A_{av}	Zero dimension	%	2 decimal places
In-situ gas content of coal	C_c	Cubic meters per ton	m^3/t	1 decimal place
Gas content of air dried basis of coal	C_{ad}	Cubic meters per ton	m^3/t	1 decimal place
Gas content of dry ash-free base of coal	C_{daf}	Cubic meters per ton	m^3/t	1 decimal place
Coalbed's gas content under abandonment pressure conditions	C_{ga}	Cubic meters per ton	m^3/t	1 decimal place
Coalbed's gas content under the original reservoir conditions	C_{gi}	Cubic meters per ton	m^3/t	1 decimal place
Apparent density of air dried basis of coal	D	Tones per cubic meter	t/m^3	2 decimal places
Dry ash-free base apparent density of coal	D_{daf}	Tones per cubic meter	t/m^3	2 decimal places
Coalbed methane geological reserves	G_i	A hundred million cubic meters	10^8 m^3	2 decimal places
Geological reserves within the well control scope of coalbed methane	G_{iw}	A hundred million cubic meters	10^8 m^3	2 decimal places
Cumulative gas production of gas-well	G_{PL}	A hundred million cubic meters	10^8 m^3	2 decimal places
Coalbed methane recoverable reserves	G_r	A hundred million cubic meters	10^8 m^3	2 decimal places
Net thickness of coalbed	h	meter	m	1 decimal place
Coalbed buried depth	H	meter	m	1 decimal place
Permeability	k	Millidarcy	$10^{-3} \mu\text{m}^2$	2 decimal places
Moisture of air dried basis of coal	M_{ad}	Zero dimension	%	2 decimal places

Appendix C (Normative)

Preparation requirements of coalbed methane's proved reserves report

C.1 Text of the report

C.1.1 Foreword

Coalbed methane field name, geological location, registration area-block name and permit-license number, existing gas content area and reserves, this-time's declared gas content area and reserves, and declaration organization.

C.1.2 Overview

Brief history of exploration-development, exploration background of coal field, coal production overview, implemented work-load of coalbed methane exploration, exploration organization, information deadline, and obtained material information, etc.

C.1.3 Geological conditions

Regional tectonic position, structural features, development features of layer and coalbed, hydrogeological characteristics, geological representative of coalbed methane exploration engineering, reservoir characteristics, gas content and its distribution characteristics etc.

C.1.4 Extraction test and capacity analysis

Time of single-well extraction or small well-network development test, production process, single-well and well-network capacity as well as dynamic characteristics of development-production etc.

C.1.5 Reserves calculation

Reserves calculation way and method selection, reserves grading; and classification determination, parameters determination, calculation results, methods and basis of recoverable reserves calculation and determination of recovery ratio; as well as the reasons and basis of parameter change of reserves before and after the reserves' re-calculation or account-calculation.

C.1.6 Reserves evaluation

Scale evaluation, comprehensive geological evaluation, economic evaluation, feasibility evaluation, etc.

C.1.7 Existed problems and suggestions

C.2 Attaching figures and tables of report

- a) Attaching figures: gas field position and the registration area-block map, gas content area chart, coalbed floor contour map, coalbed thickness contour map, contour map of coalbed gas content, yield curve of main gas-well gas-water, determination of reserves parameter basis and other figures.
- b) Attaching tables: geological basic data sheets of gas field, extraction achievement table, table of reservoir simulation results, raw data sheet of reserves parameters, reserves parameters and reserves calculation tables of main gas well or sub unit, development data table, and economic evaluation table.

C.3 Report attachments ¹⁾

Attachments may include: geological study report, research report on coal reservoir description, reserves parameters study report, key-well single-well evaluation report, trial production report, etc.

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¹⁾ Non-essential material.

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