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Empirical Analysis of China Aluminum Futures Yield Effect Based on GARCH

Huang Shan[1], Li Zhenqing[1]
[1]College of Mathematics and finance, Hunan University of Humanities, Science and Technology, Loudi 417000, Hunan, China

Abstract: The rapid development of China's overall economy will naturally drive the rise of China's aluminum industry, which will inevitably lead to some new achievements in the aluminum industry in various aspects, which not only highlights the continuous improvement of the comprehensive competitiveness of China's aluminum industry, but also reflects in aluminum. The relationship between supply and demand in the market is increasingly balanced. However, compared with developed countries such as the United States and Russia, there are still some gaps in China's aluminum industry. Using GARCH model to carry out GARCH model for the monthly closing price data of aluminum futures in the past 20 years to estimate the yield and variance of aluminum futures, and to understand the relationship between the basic characteristics of aluminum futures' yield volatility and the price and return rate of aluminum futures. The comparison between the models was carried out through experiments, and the best model suitable for studying the yield of aluminum futures was obtained. Finally, through the data analysis to predict the overall development trend of aluminum over time, to find out the current state of China's aluminum industry development and potential threats. Research shows that China's aluminum futures yield has GARCH effect, and predicts that the future aluminum futures yield will decline slightly, so it can give China's aluminum supply and demand situation, aluminum industry comprehensive competitiveness and aluminum industry related system establishment. Provide policy recommendations for policy support.

Keywords: ARCH，GARCH，EGARCH，Yield

I. INTRODUCTION

Investigate whether aluminum futures have the GARCH effect, explore the best model for studying aluminum futures yields, explore the characteristics of aluminum futures' yield changes with time, and make a basic understanding of aluminum futures prices and yields in the past 20 years. Forecasting the future development trend of the aluminum industry, we can find out the problems existing in the development of Chinalco and provide reference suggestions.

Regarding predictability, Zhang Fan proposed that the ARCH model predicts it by establishing a conditional variance model. The autoregressive conditional heteroskedasticity ARCH model takes all available information as a premise and uses autoregressive forms to explore the variance of variance [1] . For a time series, the information that it can use at different time periods will be different, so that its conditional variance will be different. With the ARCH model, the conditional variances that change with time can be simulated. In the

ARCH regression model, the conditional variance is a positive function of the lag error term, and the GARCH model is essentially an ARCH model with a variance containing many error terms.

Wang Yan briefly describes the advantages and disadvantages of comparing the GARCH model with the ARCH model. The ARCH model is generally used to describe the conditional variance of variables and the volatility characteristics of its variables. The random disturbances of the regression model generally require the same variance, but still There will be some models of random perturbation terms with heteroscedasticity, and the stability is much worse than the same variance. For this particular model, the ARCH model needs to be solved. However, due to the limitations of the ARCH model, its lag period is very large. The conditional variance depends on the variance before many times. There are many parameters to be estimated. As the GARCH model improved by the ARCH model, it can be better. Avoid these shortcomings of the ARCH model. And the GARCH model has a more elaborate lag structure than the ARCH model [2]. Among them, GARCH(1,1) is the most commonly used model. Compared with the classical ARCH model, it has the characteristics of solving the problem of heteroscedasticity and homoskedasticity. Its estimation amount is much reduced, and it is more convenient and simple to use. More applicative. Therefore, it is possible to use the GARCH model instead of the high-order ARCH model, making it easier to study the operation process.

Xiao Nan pointed out that the coefficients passed through the GARCH model can be used to estimate the persistence and stability of time series fluctuations, that is, the past fluctuation characteristics that continue in the future. Leverage is a significant feature of the rate of return, that is, the impact of market decline is more intense than the impact of market upswing. The corresponding modeling method is some nonlinear GARCH models [3].

Yan Zhigang proposed that GARCH is actually an autoregressive model of heteroscedastic time series, which uses past variance and past variance predictions to predict future variance [4]. Heteroscedasticity refers to a feature of variance that changes with time and can be understood as a dependence on the past; auto regression can represent the relationship between predicted values and past observations. Therefore, when aluminum futures yields fluctuate, it can be used to predict the future trend of aluminum futures yield.

II. Model establishment and analysis

A. Data collection

In order to better study the characteristics of the yield and volatility of China's futures market, the sample was from March 1999 to March 2019, with a total of 2,801 data, and the data was taken from the CSMAR database.

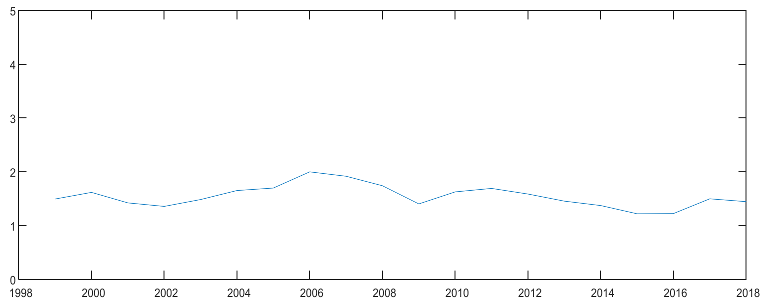


Figure 1 Aluminium monthly closing price data average

By averaging the annual closing price data to get the above figure, it can be seen that the closing price of aluminum futures is relatively stable, and continues to fluctuate within a range. There is no tendency to rise and fall, and it may be more common use of aluminum products. Related to the attributes. In recent years, the total consumption of primary aluminum in China has increased year by year. The three major industries of aluminum consumption are construction, transportation and electric power.

B. Empirical test of GARCH effect

1) Statistical description of aluminum yield

Yield: r=log(p)-log(p(-1))

T: Closing date

P: closing price

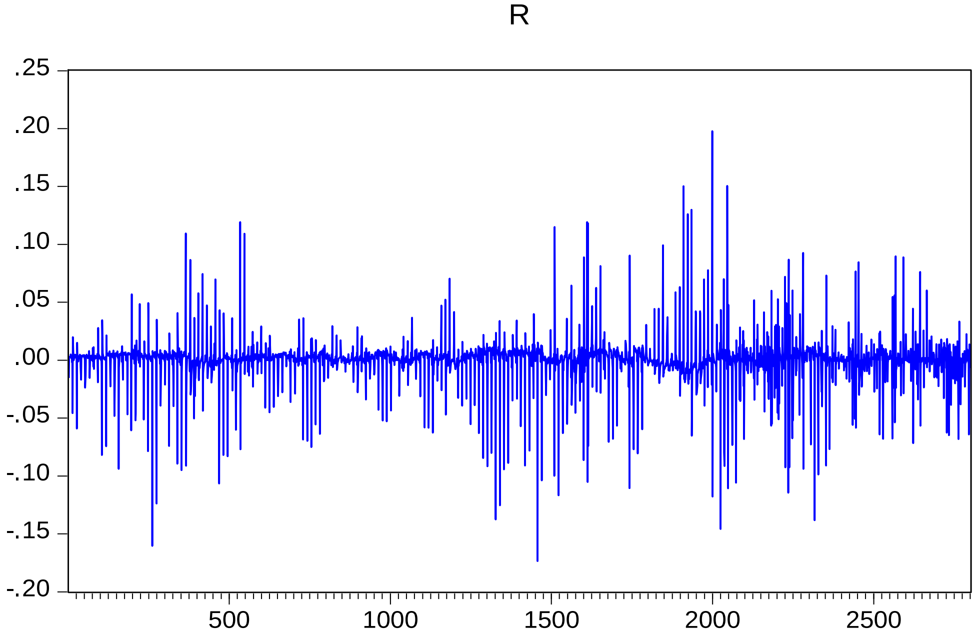


Figure2 Statistical description dialog box for futures yield sequence r

Figure2 shows the return sequence of the yield of aluminum futures in the past 20 years. From Figure 2, it can be seen that the aluminum futures yield series is not a random walk. The aluminum futures yield series has obvious characteristics and high returns. The rate is accompanied by a high rate of return, which is accompanied by a low rate of return, indicating a clear volatility cluster. Therefore, it can be preliminarily determined that there is a conditional heteroskedasticity in the return sequence of the income. The autoregressive conditional variance ARCH model is used to describe the conditional variance and volatility, so we can use the ARCH model to study the fluctuation characteristics of aluminum futures yield.

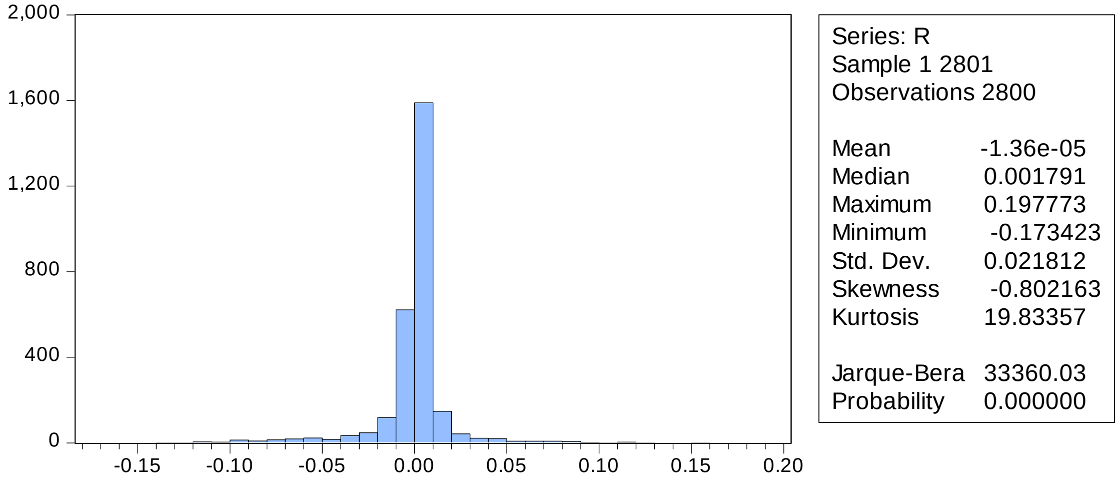


Figure 3 Histogram of the futures yield series r and related statistics

According to the histogram and related statistic analysis of the aluminum futures yield series in Figure 3, the yield series of aluminum futures has the phenomenon of tail width and peak tip. The yield kurtosis of aluminum futures is = 19.83357>3, and the p-value of JB statistic is less than 0 than the significance level of 0.05, indicating that the aluminum futures yield series are not normally distributed.

2) Stationarity test of aluminum yield series

Date: 03/27/19 Time: 22:19
Sample: 1 2801
Included observations: 2800

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.221	-0.221	137.28	0.000
		2	-0.044	-0.098	142.72	0.000
		3	-0.016	-0.051	143.43	0.000
		4	-0.031	-0.054	146.08	0.000
		5	-0.033	-0.061	149.05	0.000
		6	-0.028	-0.062	151.30	0.000
		7	-0.015	-0.051	151.93	0.000
		8	-0.029	-0.062	154.32	0.000
		9	-0.016	-0.056	155.02	0.000
		10	-0.061	-0.103	165.32	0.000
		11	-0.011	-0.078	165.68	0.000
		12	0.022	-0.033	167.09	0.000

Figure 4 Autocorrelation and partial autocorrelation plot of futures prices

From the autocorrelation and partial autocorrelation plots of the futures price in Figure 4, it can be seen that the P value of all Q statistic is greater than the significance level of 0.05, indicating that the statistic Q is not significant, but from the autocorrelation coefficient (AC) and In terms of partial correlation coefficient (PAC), the P values of the autocorrelation (AC) and partial correlation function (PAC) of each lag order are not zero. Therefore, the analysis of the correlation graph from the residual square shows that there are differences and similarities in the variance. There is no autocorrelation and partial autocorrelation problem in the aluminum futures yield series, which may be a stable time series.

To further verify its stationarity, we perform a further unit root test:

NullHypothesis:Rhasaunitroot
Exogenous:Constant
LagLength:14(Automatic-basedonSIC,maxlag=27)

		t-Statistic	Prob.*
AugmentedDickey-Fullerteststatistic		-11.49793	0.0000
Testcriticalvalues:	1%level	-3.432507	
	5%level	-2.862378	
	10%level	-2.567261	

Figure 5 Futures Yield Sequence Unit Root Test Results

From the unit root test results of the futures yield series in Figure 5, it can be seen that the ADF test value is less than the critical value of each effective level, and the probability of generating the first type of error is less than 0.0001. This shows that we can not deny the assumption that the aluminum futures return sequence is a fixed time series, then the aluminum futures yield sequence is a stationary time series.

3) Equation Estimation Statistical Description of Aluminum Closing Rate

Since the aluminum futures yield series is a stable time series, we can use equations to fit.

DependentVariable:R
Method:LeastSquares
Date:03/31/19Time:21:05
Sample(adjusted):22801
Includedobservations:2800afteradjustments

Variable	Coefficient	Std.Error	t-Statistic	Prob.
C	-1.36E-05	0.000412	-0.032916	0.9737

R-squared	0.000000	Meandependentvar	-1.36E-05
AdjustedR-squared	0.000000	S.D.dependentvar	0.021812
S.E.ofregression	0.021812	Akaikeinfocriterion	-4.812366
Sumsquaredresid	1.331648	Schwarzcriterion	-4.810245
Loglikelihood	6738.312	Hannan-Quinncriter.	-4.811600
Durbin-Watsonstat	2.442426		

Figure 6 Equation estimation results

It can be seen from the estimation results of equation 6 above that the intercept term has a P value of 0.9737 at the significance level greater than the significance level of 0.05, and the results are not significant. In order to better estimate the equation, the regression results are analyzed by regression residuals.

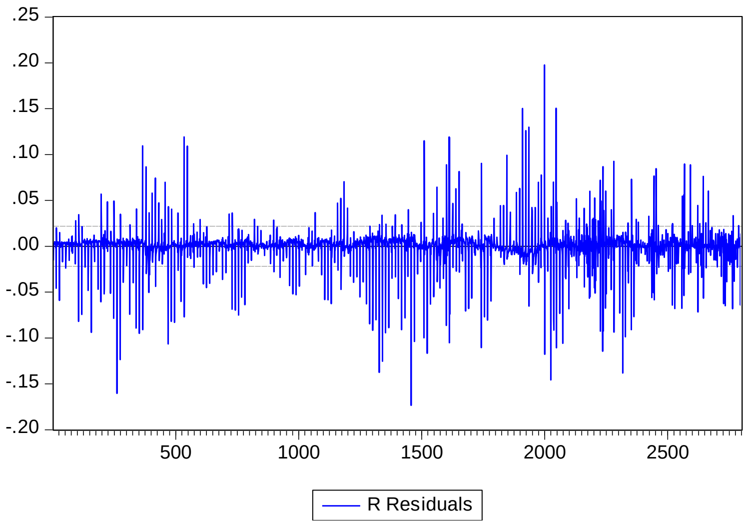


Figure 7 Regression equation residual diagram

By observing the residual equation of the regression equation in Figure 7, we find that there may be heteroscedasticity of the residual. To further prove this heteroscedasticity, we use the ARCH effect test to test the residual.

Heteroskedasticity Test: ARCH

F-statistic	68.74916	Prob. F(1,2797)	0.0000
Obs*R-squared	67.14785	Prob. Chi-Square(1)	0.0000

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 03/27/19 Time: 22:43
Sample (adjusted): 3 2801
Included observations: 2799 after adjustments

Figure 8 Residual ARCH effect test results

From the estimation results shown in the residual ARCH effect test results in Figure 8 above, it can be concluded that when the significance level P value is 0, the intercept term is significant, indicating that the residual sequence has a high-order ARCH effect. Therefore, if we want to explore the aluminum futures yield series, we can use the ARCH and GARCH models.

In summary, through the above test results, it is proved that the time series has heteroscedasticity, that is, the ARCH effect. The residual ARCH effect test of the ARCH-LM test shows that the residual sequence has a high-order ARCH effect. The GARCH model is called a high-order ARCH model. The essence of GARCH is an

ARCH model with variance and infinite error term. We can use a simple GARCH model instead of the high-order ARCH model and replace it with GARCH model. The ARCH model can better solve the problem of large ARCH lag period and many estimated parameters, thus reducing the estimator and making the operation easier. GARCH(1,1) is the most commonly used model in GARCH model, so it is the best way to predict the yield of aluminum futures by establishing GARCH(1,1) model.

C. ARCH estimation

DependentVariable:R
Method:ML-ARCH(Marquardt)-Normaldistribution
Date:03/31/19Time:21:07
Sample(adjusted):22801
Includedobservations:2800afteradjustments
Convergenceachievedafter32iterations
Presamplevariance:backcast(parameter=0.7)
GARCH=C(2)+C(3)*RESID(-1)^2+C(4)*RESID(-2)^2+C(5)*RESID(-3)^2
+C(6)*RESID(-4)^2+C(7)*RESID(-5)^2+C(8)*RESID(-6)^2+C(9)
*RESID(-7)^2+C(10)*RESID(-8)^2+C(11)*RESID(-9)^2

Variable	Coefficient	Std.Error	z-Statistic	Prob.
C	3.16E-05	0.000371	0.085057	0.9322
		VarianceEquation		
C	0.000401	3.86E-06	103.8991	0.0000
RESID(-1)^2	0.107131	0.011225	9.544262	0.0000
RESID(-2)^2	0.015353	0.003977	3.860254	0.0001
RESID(-3)^2	-0.003426	0.006507	-0.526452	0.5986
RESID(-4)^2	-0.008850	0.002343	-3.777787	0.0002
RESID(-5)^2	-0.007062	0.000932	-7.576889	0.0000
RESID(-6)^2	-0.007673	0.000347	-22.12855	0.0000
RESID(-7)^2	-0.007122	0.000687	-10.36699	0.0000
RESID(-8)^2	-0.007918	0.000374	-21.14499	0.0000
RESID(-9)^2	0.024340	0.003237	7.518907	0.0000

Figure 9 ARCH estimation results of aluminum futures yield series

From the ARCH estimation results of the 9 aluminum futures yield series above, it can be seen that the average equation is still not significant (the intercept P value is 0.9322), but the residual term of the mean equation has a high-order ARCH effect, and can be seen Very significant results.

D. GARCH estimation

GARCH=C(2)+C(3)*RESID(-1)^2+C(4)*GARCH(-1)

Variable	Coefficient	Std.Error	z-Statistic	Prob.
C	0.000141	0.000340	0.413952	0.6789
		VarianceEquation		
C	0.000382	4.71E-06	81.00250	0.0000
RESID(-1)^2	0.211525	0.018945	11.16529	0.0000
GARCH(-1)	0.013480	0.007914	1.703356	0.0885

Figure 10 GARCH estimation results of the aluminum futures yield series

From the GARCH estimation results of the 10 aluminum futures yield series above, it can be seen that the mean equation is still not significant (the intercept term P value is 0.6789), but in the GARCH equation, the ARCH and GARCH coefficients are very obvious.

E. GARCH-M estimation

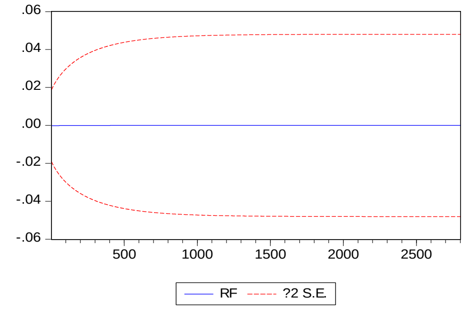
The model GARCH(1,1) is established, and the parameters of the equation are estimated. The results are shown in the figure.

GARCH=C(3)+C(4)*RESID(-1)^2+C(5)*GARCH(-1)

Variable	Coefficient	Std.Error	z-Statistic	Prob.
@SQRT(GARCH)	0.010432	0.071999	0.144886	0.8848
C	-0.000263	0.001519	-0.172898	0.8627
		VarianceEquation		
C	1.87E-06	1.77E-07	10.55081	0.0000
RESID(-1)^2	0.013857	0.000705	19.65348	0.0000
GARCH(-1)	0.982901	0.000801	1227.769	0.0000

Figure 11 GARCH-M estimation results of aluminum futures yield series

From the GARCH-M estimate of the aluminum futures yield series, the results of the analysis in Figure 11 above can be concluded that the p-value of the intercept term is 0.8627 greater than the significance level of 0.05, and the mean equation is not significant, but for the ARCH, the mean equation is well obtained. Improvement.



Forecast: RF	
Actual: R	
Forecast sample: 1 2801	
Adjusted sample: 2 2801	
Included observations: 2800	
Root Mean Squared Error	0.021808
Mean Absolute Error	0.010270
Mean Abs. Percent Error	95.56999
Theil Inequality Coefficient	0.998269
Bias Proportion	0.000000
Variance Proportion	0.997464
Covariance Proportion	0.002536

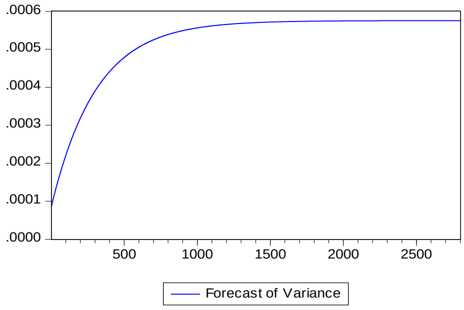


Figure 12 Predicted graph of aluminum futures yield series

According to the established GARCH(1,1) model, China's aluminum futures yield is predicted from 1999 to 2018, and the forecast curve is shown in Figure 12. It can be seen from Figure 3.12 that the fluctuations in the yield of aluminum futures in the past 20 years are relatively stable and fluctuate within a certain range. The average prediction error over the entire time period is 2.1808%. This gives us the excellent characteristics of the GARCH(1,1) model: the estimated required parameters are small, and the prediction results obtained are highly accurate. From GARCH (1,1), China's aluminum futures yield will continue to rise, but the gains are relatively stable, and the magnitude will not be large. 觟

F. EGARCH estimate

Since the aluminum futures yield series has a certain bias (Figure 3.3), we can try to use the EGARCH model to further fit the yield series of aluminum futures.

LOG(GARCH)=C(2)+C(3)*ABS(RESID(-1)/@SQRT(GARCH(-1)))+C(4)
*RESID(-1)/@SQRT(GARCH(-1))+C(5)*LOG(GARCH(-1))

Variable	Coefficient	Std.Error	z-Statistic	Prob.
C	0.000664	0.000274	2.421660	0.0154
		VarianceEquation		
C(2)	-7.371481	0.152185	-48.43768	0.0000
C(3)	0.416635	0.022059	18.88710	0.0000
C(4)	0.045623	0.018778	2.429636	0.0151
C(5)	0.072311	0.019521	3.704332	0.0002

Figure 13 EARCH Estimation Results of Aluminum Futures Yield Sequence

According to the EGARCH-M estimation results of the aluminum futures yield series in Figure 13 above, the P value is 0.0154 less than the significance level of 0.05, indicating that the coefficient of the standard deviation in the mean equation is significant compared to the ARCH model and GARCH. The coefficients of the model and the mean equation are better optimized. Therefore, we believe that EGARCH can be used to fit the aluminum futures yield series.

III. Conclusions and Recommendations

A. Conclusion

The analysis of the above experimental results shows that the monthly yield of aluminum futures in the past 20 years does have a GARCH effect. In the case of considering the asymmetry of the closing price fluctuation, the coefficient of the intercept term and the standard deviation in the mean equation is significant at the significance level of 0.05, and the EARCH equation has a good fitting effect. Therefore, we think that Use EGARCH to fit the aluminum futures yield series. According to the results of GRACH-M fitting, the aluminum futures yield has been fluctuating within a range. The GARCH (1,1) has a tendency to decline in China's aluminum futures yield, but the decline is relatively stable. The magnitude will not be large.

B. Recommendations

China's metal mineral resources are very large in total, which can be said to be the "blood" of modern industry in China. Its main characteristics are the coexistence of multiple metals, the difficulty of smelting and the cumbersome process, which is difficult to be effectively utilized. Among them, aluminum, as the most resource in metal minerals, is widely used in all aspects of the production and life of ordinary people. On the one hand, in the economy With the rapid development of the global economy, the quality of life of the people is constantly improving and gradually achieving common prosperity. On the other hand, the development of aluminum industry in China is getting better and better, the output of aluminum products is also increasing, and aluminum has new in all walks of life. The development of the group that needs to use it to buy it is also growing. The socialist market economy has promoted the supply-side reform and the goal strategy of strengthening China's internal demand. The aluminum industry should also explore the market more deeply in this economic context, and master and understand aluminum in the construction industry, transportation industry, The demand of the three major industries in the power industry produces products that the society needs to meet the needs of the market. In response to the above market demand, the following suggestions are made:

First, effectively and maximize the use of metal resources in the natural world, improve the utilization of aluminum resources, increase the smelting of complex metals, and increase the total amount of metal resources available. Enhance the recycling of secondary metals, strengthen the protection of metal resources and environmental awareness. While developing and mining aluminum metal, we must also pay attention to not destroying the ecological environment, so that resources and environment can be combined to reduce waste of resources and environment. Destruction, at the same time should avoid high energy consumption and low utilization, waste water, waste gas and waste residue should pay attention to meet emission standards, and make a good contribution to energy conservation and emission reduction;

Second, optimize the production process of aluminum products, gradually realize the improvement of industry and technology, and further improve the monitoring and supervision standards of the aluminum industry;

Third, improve the quality standards of aluminum products, develop standards that are conducive to the application of aluminum products; strengthen technical supervision. Strengthen China's efforts in the development and research of new aluminum products, and formulate standard benefits that are conducive to employment in the aluminum industry, in order to attract more high-tech industry winners and capable and capable workers, and strive to strengthen independent innovation and research More aluminum products suitable for production and life;

Fourth, establish corresponding propaganda institutions, commit to the promotion of aluminum products, and publicize the public for the public, highlighting the unique metal advantages and industry status of aluminum products, and establishing a good public image for them.

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