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Research Article

Economic Justification of the Price for Ethylene under Conditions of the Monopolistic Market

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ABSTRACT:

Annotation: Presently in the Russian practice under conditions of a monopolized market the members of market relations, specifically sellers; unreasonably drive up the offer price for ethylene which consequently results in an unjustified rise in prices for polyvinylchloride resin.

The research objective is to consider the available approaches to price formation for the monopolistic market of ethylene and develop a model (formula) for ethylene pricing based on peculiarities of the market condition and observance of the economic balance of interests of the market participants.

By using the leading methods of analyzing the statistical data on the dynamics of price for ethylene and polyvinylchloride resin the authors of the paper proved that it is reasonable to use market approaches to price formation as a basis of pricing for the final product that is in demand on the market since the cost of a basket of raw materials for chemical products is calculated based on the market prices.

The formula of ethylene pricing was elaborated in the paper through a retroactive accounting on the basis of a market valuation of the final product – polyvinylchloride resin and technological interrelation between the raw materials and a final product using a membrane production of a caustic soda.

Testing results of the proposed method for ethylene pricing are provided, a detail calculation of production cost of the polyvinylchloride resin is presented, and on the basis of it – the cost of processing that is taken into account upon price formation for raw materials – ethylene.

Using this formula for ethylene pricing will allow the participants of market relations to observe the balance of economic interests basing on the laws of a monopolistic market functioning and market approaches to price formation, as well as to secure a decrease in the offer price for the final products – polyvinylchloride resin.

Such researches can be useful for the enterprises and companies that manufacture chemical products based on the primary raw material – ethylene.

Key words: ethylene, polyvinylchloride resin, price formation, monopolistic market, processing cost, market of chemical products

INTRODUCTION

For the last several years an increase in demand for ethylene for producing chemical products – polyvinylchloride resin (PVCR) is observed. It is primarily associated with modernization of the operating plants producing PVCR and with the introduction of new production sites. However the production sites and markets for ethylene are focused in different regions of the Russian Federation which allows the sellers to dominate on the respective market segment (to be monopolists) and state the level and dynamics of prices for ethylene.

Under conditions of advanced prices for ethylene the balance of economic interests of the seller and buyer is not observed due to the increased production cost of the produced polyvinylchloride resin and lower level of the products profitability than the desired one.

The balance of economic interests represents a profit maximization as a result of the activity of economic entities under competitive conditions. However when the seller dominates on the market and has a monopoly power it mostly results in control over the price and quantity of products and enables to gain the highest profit at the expense of other market participants.

The authors of the paper focused primarily on the economic justification of applying the price formation method to the product under conditions of imperfect competition with due account for the existing Russian practice of the chemical product market operation and specific nature of the chemical sector.

The issues of studying the pricing peculiarities at a monopolistic market in different industrial sectors and rules of conduct of the monopolistic market participants are presently dealt with by both Russian and foreign scholars. Thus, the founders of the theory of monopolistic competition are such foreign scholars as: P. Sraffa, E. Chamberlin, J. Robinson, R. Triffin, R. Pindyck, D. Rubinfeld and many others. They proved in their papers that there are no self-regulation warranties under conditions of a multicommodity imperfect market, therefore other approaches to price formation shall be applied in contrast to a competitive market [1-5].

Among Russian scientists who consider the price formation issues and methodology of product pricing under conditions of imperfect competition, as well as the influence of the macroeconomic factors and state policy the following can be distinguished: Agapova T.A., Seregina S.F., Butyrkin A.Ya., Volonskiy V.A., Koryagin G.I., Gerasimenko V.V., Lipsits I.V., Friedman M. and many other [6-10].

Taking into account the coverage of study of the economy laws and monopoly operation, the question “How to observe the economic interests of the market participants where the seller dominates even in terms of geography and thus manipulates the price for the product for the purpose of making a maximum profit?” is still pressing.

In this regard it becomes relevant to study theoretical and methodological approaches to price formation under conditions of monopolistic market and observance of economic interests of the ethylene seller and buyer, as well as to develop the economically justified formula for ethylene price.

MATERIALS AND METHODS

Basing on the theory and practice of price formation in the market economy [9, 10] apart from cost (traditional) approaches to pricing there are also market methods that have a certain specific nature of application.

Taking into account that the ethylene market is a monopolized one and in some regions of Russia the ethylene producers dominate at a respective market segment (since they are the only ones) that supplies the raw materials for PVCR production, it is reasonable to use the market approach to price formation since the cost of a basket of raw materials is calculated based on the market prices.

In the modern practice there are the following approaches to ethylene pricing:

1) The ethylene price is determined as a weighted average cost of market prices for the raw materials used for ethylene production – naphta and polyvinylchloride resin. The calculation formula is as follows:

$$P_{ethylene} = 0.8 \times P_{naphta} + 0.2 \times P_{PVCR}, \quad (1)$$

where $P_{ethylene}$ - market price for ethylene;

P_{naphta} - market price for the light straight run (“naphta” grade);

P_{PVCR} - market price for polyvinylchloride resin.

2) The ethylene price is determined basing on the market valuation of the raw materials basket for its production. The calculation formula is as follows:

$$P_{ethylene} = (C_{rawmaterialsbasket} - C_{propylene} - C_{by-products} - C_{processing}) \times \%\ profitability, \quad (2)$$

where $C_{rawmaterialsbasket}$ - total value of the market price for naphta and ethane.

Basing on the formula (1) where the market price for PVCR as a primary product obtained from ethylene is used, the application of a reverse pricing for ethylene is possible basing on the comparative costs of PVCR less the cost of PVCR processing.

The provisions of the economic theory are not an imperative of relations between the ethylene producer (ethylene seller) and PVCR producer (ethylene buyer) in practice. If the producer of the primary product – PVCR that dominates on the regional market applies the market approach to PVCR pricing, then the producer of raw materials – ethylene, operating in the same conditions and dominating on the regional market can also apply the market approach to ethylene pricing basing on the market price for PVCR, since the latter is more affordable and transparent in the mass media as it has a market quotation.

Based on the laws of the economic theory in pricing and taking into account the peculiarities of a monopolistic market, the authors of the paper proposed a formula of the price for ethylene which is based on the level of the market price for polyvinylchloride resin and correction factors that take into account the technological features of the production process of final products.

The proposed methodological approach to justification of price for ethylene includes the market valuation of the final product – polyvinylchloride resin, which enables to observe the balance of economic interests of both seller and buyer of ethylene.

The authors of the paper elaborated an ethylene pricing formula on the basis of balance of economic interests of seller and buyer under conditions of a monopolistic market.

The calculation formula of the ethylene price proposed by the authors of the paper has the following form:

$P_{ETHYLENE} = (P_{PVC\text{-}R} *a+b*c)*0.8-d-e,$ (3)

where $P_{PVC\text{-}R}$ - price on terms FCA-producer ex VAT, rubles/tonne;

a –tonnes of PVC produced from 1 tonne of ethylene;

b –tonnes of caustic soda obtained in the process of production of 1 tonne of PVC;

c- average price for caustic soda in the current year, rubles/t ex VAT;

0.8 – is a factor taking into account the profitability of PVC production assessed at 20% which corresponds to the indicator for such kind of enterprises;

d- cost of processing of “a” tonnes of PVC;

e – cost of raw materials for chlorine production.

The calculation formula of “e” indicator has the following form:

e=0.595×2.18×5000,

where 0.595 – unit consumption of chlorine per1 tonne of PVC;

2.18 – tonnes of PVC produced from 1 tonne of ethylene;

5000 – weighted average assessed value of raw materials for chlorine.

In order to justify the design factors used in the formula of price for ethylene it is required to evaluate the economy of polyvinylchloride resin production.

Basing on the official data of the Federal State Statistics Service and annual reports of one of the major PVC producers, the results of the production cost accounting for chlorine, vinylchloride and suspended polyvinylchloride resin are presented.

RESULTS

Presently there are four operating enterprises producing polyvinylchloride resin (PVCR) in the Russian Federation: OOO RusVinil (Kstovo, Nizhny Novgorod region), AO Sayanskkhimplast (Sayansk, Irkutsk region), AO Bashkirskaya Sodovaya Kompaniya (Sterlitamak, the Republic of Bashkortostan), OAO Plastkard (Volgograd).

The total capacity of PVCR producers as of 2016 is presented in table 1.

Table 1 - Total capacity of PVCR producers as of 2016

PVCR producer	Annual capacity of the plant, thous.tonnes	Caustic production method
OOO RusVinil	300	membrane
AO Bashkirskaya Sodovaya Kompaniya	240	mercury, orifice
AO Sayanskkhimplast	280	orifice
OAO Plastkard	97.2	orifice

The assessment of PVCR production economy is effected by its technological production scheme which is based on application of the primary raw component – ethylene by way of suspension polymerization.
Suspension polymerization – is a method working on a periodic scheme and is the most common method of polyvinylchloride resin production.
Polyvinylchloride of different grades with the common formula $[-CH_2-CHCl-]_n$, n=100-2500 is obtained by the method of suspension polymerization of vinylchloride monomer during 9-14 hours at a temperature of 30-70°C and pressure of 4-12 kgf/cm^2 on the periodic scheme in reactors made from stainless steel 1X18H10T or glass lined with an agitator with a capacity of 10-25 m$^{3.}$
PVC is obtained from 4 primary components - vinylchloride, water, suspending agent and polymerization initiator.
Vinylchloride CH_2=CHCl is obtained from ethylene - ethylene + Cl_2 at the ratio of 1:1.2 to 1:3 at 200-700°C (with a catalyst - at 45-60°C) with diluent (dichloroethane).
The technology of vinylchloride (VC) production from ethylene takes a course of three stages [14].
On the first stage dichloroethane (DCE; 1,2 dichloroethane) is obtained by means of direct chlorination, and on the second stage – by means of oxychlorination.
Both reactions are exothermic. DCE obtained by means of direct chlorination is delivered directly to the pyrolysis furnace without any additional purification. DCE obtained in the process of oxychlorination passes through purification stage (DCE distillation) before it is delivered to the pyrolysis furnace.
On the third stage DCE is cracked in the pyrolysis furnace. VCM that has formed in this process, as well as HCl and unreacted DCE are detached on the stage of VC distillation. VC is temporarily kept in the tank while HCl returns to the stage of oxychlorination, and unreacted DCE – to the pyrolysis furnace.
The industrial water that has formed at that gets purified. The residue gases that contain contaminants, as well as liquid wastes are delivered to the HCl recycling stage and are separated into HCl, CO2 and water.
Due to reutilization of the recovered HCl in the process of oxychlorination a complete transformation of the supplied chlorine is achieved.

The scheme shows some stages of VC production process (Fig. 1).

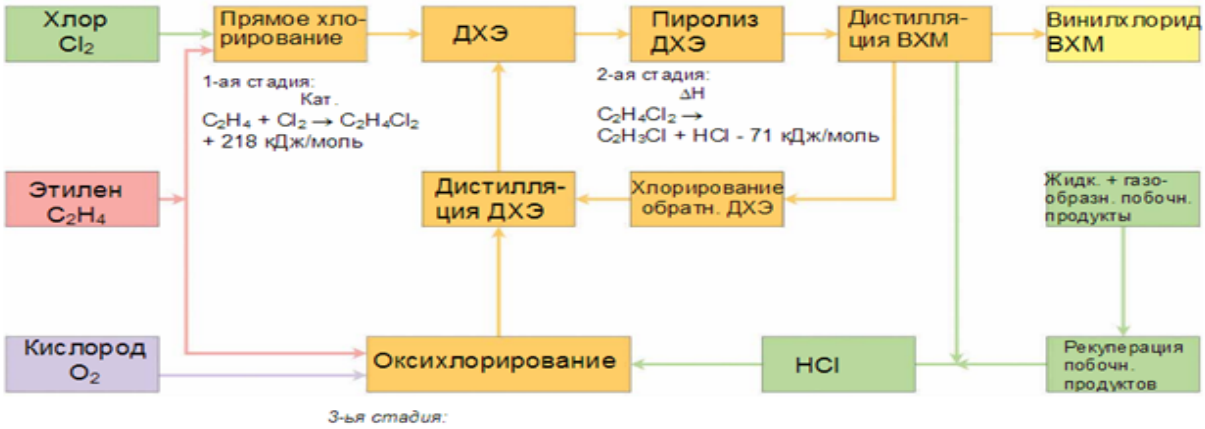

Figure 1 – Scheme of vinylchloride production process [14]

In this production process the chlorine acts as a semi-finished product that is obtained as a result of a sodium chloride electrolysis.

The modern productions of chlorine and caustic have a brine circulation system specially developed for the membrane technology. Stronger depletion of the sodium chloride in membrane cells implies lower degree of recirculation and considerably less equipment than in mercury plants of the same capacity for instance. Moreover in membrane units the brine passes through the preparation stage specially adapted for the unit needs and type and quality of the brine used which will ensure supply of a high quality brine to the membrane cells.

The obtained chlorine is removed from the cell together with the depleted brine. If a high-purity chlorine is required (for instance for the subsequent production of VCM) then hydrochloric acid can be added to the supplied brine in order to reduce the oxygen content in it.

Moist gaseous chlorine after cooling and filtering is either delivered to the consumer shop directly (for instance, hydrochloric acid production) or gets additionally dehumidified and compressed before its delivery to the consumer shop (for instance, VCM production) or before liquefaction for storage in tanks.

The membrane electrolysis plants also include the caustic liquor circulation system. A partial flow of the product 32% NaOH is diluted with demineralized water to 30% concentration and returns to the membrane cells as a caustic liquor. The concentration of the rest caustic-product can be enhanced if necessary.

Hydrogen as a valuable by-product can be supplied after cooling and filtering to such consumers as production of hydrochloric acid or hydrogen.

The production scheme of caustic soda by means of membrane method is presented in figure 2.

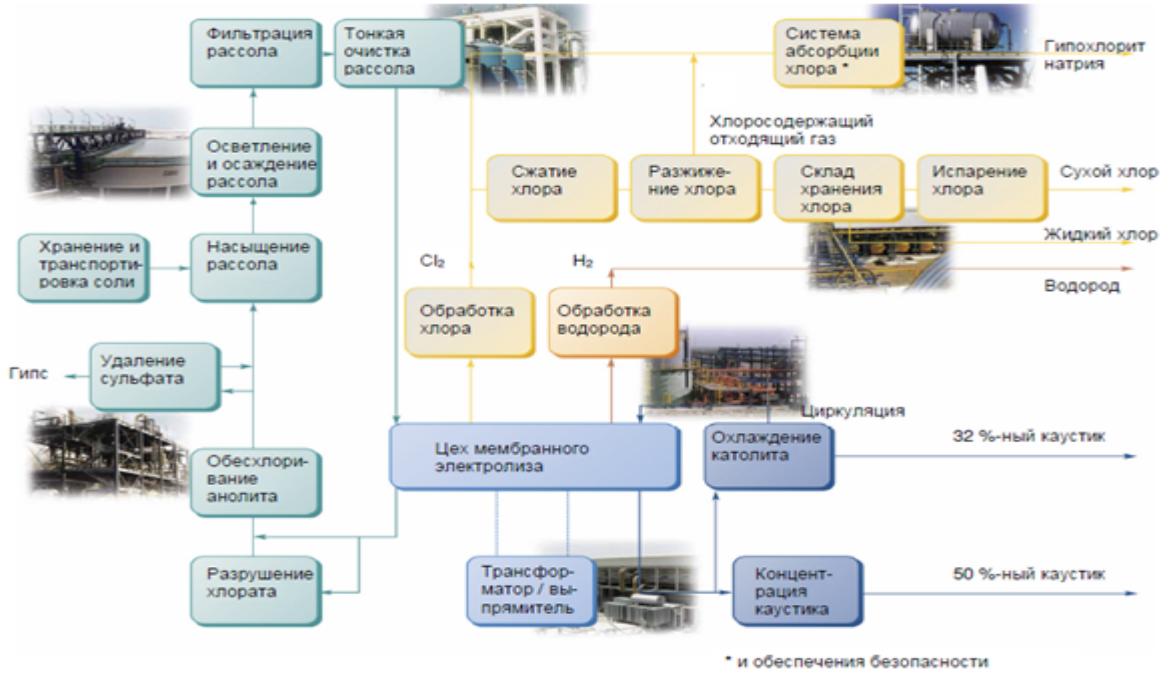

Figure 2 - Scheme of caustic soda production by means of membrane method [15]

Thus, in order to assess the level of production costs for PVCR production it is required to calculate the production cost of two semi-finished products – chlorine and vinylchloride using the resource consumption rates under membrane method.

In order to calculate costs for PVCR production it is required to assess the level of prices for energy resources and primary raw materials from producers.

1. Base rates for energy resources from the PVCR producer (hereinafter – the enterprise).

To justify the level of costs for PVCR production at the enterprise, the data of the annual report of the company for 2016 and official data of the Federal State Statistics Service were used.

The reported data on the volume of the consumed types of energy resources at the enterprise in physical and in money terms for 2016 are presented in Table 2.

Table 2 – the reported data on the volume of the consumed types of energy resources at the enterprise in physical and in money terms for 2016

Types of the energy resource	Measurement unit	Consumption volume in physical terms	Consumption volume in money terms ex VAT, mln. rubles
Heat energy	thous.Gcal	711	504.5
Electric energy	mln. kWh	751	1012.7
According to data of the annual report of the company as of 2016			

The rates for energy resources consumed at the enterprise in 2016 were calculated with due account for amended rates of 2015 with respect to the annual average growth rate in prices for the heat energy in Irkutsk region in 2016 which made 101.3% (Table 3). As for the electric energy the annual average decrease in prices was observed in 2016 as compared to 2015 which amounted 97.17%.

Table 3 – Price indexes of producers at an internal market in Irkutsk region for the heat and electric energy assessed in % as of December of the previous year [16].

Month	2015	
	Production, transfer and distribution of electric energy	Production, transfer and distribution of steam and hot water (heat energy)
January	100.24	100
February	103.78	100
March	115.12	100
April	108.79	100
May	98.54	100
June	82.62	100
July	83.47	101.15
August	82.31	101.15
September	88.38	101.15
October	92.08	101.15
November	103.37	101.15
December	107.34	109.44

Basing on the data of tables 2 and 3 the rates for heat energy and electric energy in 2016 that were used in cost accounting of chlorine, vinylchloride and PVCR were determined (Table 4).

Table 4 - Rates for energy resources consumed at the enterprise in 2015

Indicator	Measurement unit	2015
Rate for heat energy per unit	rubles/Gcal	718.79
Rate for electric energy per unit	rubles/tkWh	1,310.29

Average prices and rates for the primary types of raw materials that are used for PVCR production were determined according to the data of the Federal State Statistics Service in section “Average prices of producers for certain types of industrial products in the Russian Federation for 2016” [16] and are presented in Table 5.

Table 5 - Average prices and rates for the primary types of raw materials that are used for PVCR production for 2016

Type of raw materials	Measurement unit	Value, rubles/UM
Salt (halite)	tonne	3,907
HCl (hydrochloric acid)	tonne	2,756
Na2CO3 (sodium carbonate, soda ash)	tonne	9,984
Na2SO3 (sodium sulfite)	tonne	16,663.6
Ethylene	tonne	28,536
Nitrogen	m^3	4
Oxygen	m^3	7
Natural gas	thous.m^3	1,785
Combustible regasified liquefied natural gas	tonne	16,521
Cold water	m^3	10.51

For the production cost accounting of electrolysis products of sodium chloride at the enterprise the Table 7 presents the standard consumption rate of raw and other materials, energy resources and standards of conditional-constant costs.

Table 7 – Standard consumption rate of raw and other materials, energy resources and standards of conditional-constant costs used for chlorine production cost accounting at the enterprise

Name	UM	Consumption rate per unit of produced products
Primary raw materials		
Salt (halite)	tonne	1.695
HCl (hydrochloric acid)	tonne	0.372
Na2CO3 (sodium carbonate, soda ash)	tonne	0.008
Na2SO3 (sodium sulfite)	tonne	0.002
Energy resources		
Steam as per tariff	Gcal	0.387
Electric energy as per tariff	thous.kWh	3.03425
Circulated water	thous.m^3	0.157
Nitrogen	m^3	2.278
Conditional-constant costs		
Wages of direct labour	% from direct material costs	1
Insurance contributions to extra-budgetary funds	% from labour costs	30
General production costs	% from direct material costs	11

The results of the production cost accounting of caustic soda and chlorine at the enterprise are presented Table 8.

Table 8 – Production cost accounting of caustic soda and chlorine at the enterprise for 2016

Aggregation of costs	Cost name	UM	Costs per unit of products		
			norm	price	amount
Raw and other materials					
	Salt (halite)	tonne	1.695	3,907	6,622.37
	HCl (hydrogen chloride)	tonne	0.372	2,756	1,026.20
	Na2CO3 (sodium carbonate, soda ash)	tonne	0.008	9,984	74.88
	Na2SO3 (sodium sulfite)	tonne	0.002	16,664	28.24
Total for raw and other materials		rubles			7,751.68
Power					
	Steam as per tariff	Gcal	0.3870	718.79	278.17
	Electric energy as per tariff	thous.kWh	2.1300	1,310.29	2,790.92
	Circulated water	m3	157.0000	10.51	1,650.07
	Nitrogen	m3	2.2780	4.00	9.11
Total for the power		rubles			4,728.27
Total direct material costs		rubles			12,479.95
Wages		rubles			124.80
Insurance contributions		rubles			37.44
General production costs		rubles			1,372.79
Total production cost of the electrolysis of sodium chloride		rubles			14,014.98
Chlorine output rate in the total volume of obtained products		%			30.66
Production cost of one tonne of chlorine		**rubles**			**4,296.99**

Thus, the production cost of chlorine at the enterprise amounted to 4,296.99 rubles.

For the production cost accounting of vinylchloride at the enterprise Table 9 presents the standard consumption rate of raw and other materials, energy resources and standards of conditional-constant costs.

Table 9 – Standard consumption rate of raw and other materials, energy resources and standards of conditional-constant costs used for vinylchloride cost accounting at the enterprise

Name	UM	Consumption rate per unit of produced products
Primary raw materials		
Ethylene	tonne	0.458
Chlorine	tonne	0.595
Energy resources		
Steam as per tariff	Gcal	0.419
Electric energy as per tariff	thous.kWh	0.035
Circulated water	thous.m^3	0.181
Nitrogen	m^3	20
Oxygen	m^3	0.13
Liquefied gas	tonne	0.0666
Conditional-constant costs		
Wages of direct labour	% from direct material costs	1
Insurance contributions to extra-budgetary funds	% from labour costs	30
General production costs	% from direct material costs	11

The results of production cost accounting of vinylchloride at the enterprise are presented in Table 10.

Table 10 – Production cost accounting of vinylchloride at the enterprise for 2016

Aggregation of costs	Cost name	UM	Costs per unit of products		
			norm	price	amount
Raw and other materials					
	Ethylene	tonne	0.458	28,536	13,069.49
	Chlorine	tonne	0.595	4,297	2,556.71
Total for raw and other materials		rubles			15,626.20
Power					
	Steam as per tariff	Gcal	0.4190	718.79	301.17
	Electric energy as per tariff	thous.kWh	0.0350	1,310.29	45.86
	Circulated water	m3	181.0000	10.51	1,902.31
	Nitrogen	m3	20.0000	4.00	80.00
	Oxygen	m3	0.1300	7.00	0.91
	Liquefied gas[1]	tonne	0.0666	16,521.0	1,100.30
Total for the power		rubles			3,430.55
Total direct material costs		rubles			19,056.75
Wages		rubles			190.57
Insurance contributions		rubles			57.17
General production costs		rubles			2,096.24
Total production cost of one tonne of VC		**rubles**			**21,400.73**

[1]Note: 1 bln.m^3 of natural gas = 0.724499 mln.tonnes of liquefied gas;
1 m^3 of natural gas = 0.000724499 tonnes of liquefied gas;
92 m^3 of natural gas = 0.0666 tonnes of liquefied gas

For the production cost accounting of polyvinylchloride resin at the enterprise Table 11 presents the standard consumption rate of raw and other materials, energy resources and standards of conditional-constant costs.

Table 11 – Standard consumption rate of raw and other materials, energy resources and standards of conditional-constant costs used for polyvinylchloride resin cost accounting

Name	UM	Consumption rate per unit of produced products
Primary raw materials		
Vinylchloride	tonne	1.001
Energy resources		
Steam as per tariff	Gcal	0.42
Electric energy as per tariff	thous.kWh	0.156
Circulated water	thous.m^3	0.08
Nitrogen	m^3	1.5
Conditional-constant costs		
Wages of direct labour	% from direct material costs	1
Insurance contributions to extra-budgetary funds	% from labour costs	30
General production costs	% from direct material costs	11

The results of the production cost accounting of PVCR at AO Sayanskkhimplast are presented in Table 12.

Table 12 – Production cost accounting of PVCR at the enterprise

Aggregation of costs	Cost name	UM	Costs per unit of products		
			norm	price	amount
Raw and other materials					
	Vinylchloride	tonne	1.001	21,401	21,422.13
Total for raw and other materials		rubles			21,422.13
Power					
	Steam as per tariff	Gcal	0.4200	718.79	301.89
	Electric energy as per tariff	thous.kWh	0.1560	1310.29	204.41
	Circulated water	m3	80.0	10.51	840.80
	Nitrogen	m3	1.50	4.00	6.00
Total for the power		rubles			1,353.10
Total direct material costs		rubles			22,775.23
Wages		rubles			227.75
Insurance contributions		rubles			68.33
General production costs		rubles			2,505.27
Total production cost of one tonne of PVCR		**rubles**			**25,576.58**

The cost of PVCR processing includes the direct material costs except for ethylene costs and conditional-constant costs. The results of cost accounting of PVCR processing at the enterprise are presented in Table 13.

Table 13 - Results of processing cost accounting and gross margin (margin) of PVCR at the enterprise

Indicator	AO Sayanskkhimplast
Ethylene costs, rubles/tonne	13,069.49
Production cost of PVCR, rubles/tonne	25,576.58
Cost of PVCR processing, rubles/tonne	12,507.09
Comparative cost of PVCR for 2016, rubles (data of the Market Report)	64,541
Gross margin from PVCR sales (margin), rubles	38,964.42

Thus, basing on the data of the Federal State Statistics Service and annual reports of the enterprise being analyzed, the production cost of PVCR in 2016 averaged 25,576.58 rubles /tonne, the cost of PVCR processing amounted 12,507.09 rubles/tonne, and gross margin from PVCR sales amounted 38,964.42 rubles/tonne.

DISCUSSION

The principle of imperfect competition functioning and monopolistic market regulation is described in detail in the scientific papers of a team of well-known economists R. Pryndak and D. Rubinfeld, C.R. McConnell and S.L. Brue [5, 11]. They noted that one of the methods to eliminate the expenses of the imperfect competition markets is a state antimonopoly regulation including regulation of the product price. At that for natural monopolies just as in case with the ethylene market either direct control of prices is applied or the profit margin of monopolist and productions costs are regulated.

In order to justify the profit margin the economic theory [6, 10, 11, 13] applies classical approaches to price formation that enable to determine the economically justified price for the product on the basis of profit and cost indicators. Such approaches include: cost method, when the market price for products being sold by the seller is determined as a sum of costs and profit that is common for the given sphere of activities, and market approach based on relation of demand and supply, in other words on the market condition.

Under conditions of a monopolized market the cost method does not take into account the interests of the buyer, and in this case the seller can artificially overstate the level of production costs and establish a desired profit margin even if it corresponds to the industrial level. Earlier the researches of the team of authors T.B. Leibert and E.A. Khalikova studied the issues of pricing of chemical products basing on the cost method and methodology of production cost formation for the produced products in the chemical sector [18, 19, 20].

According to the authors of the paper, in the conditions being considered it is reasonable to apply the market approach that takes into account the economic interests and concurrence of the participants of market relations. However under conditions of antimonopoly regulation the method of determining the price for raw materials should be used basing on the market demand for the final product that will ultimately ensure the desired profit for both the seller and buyer of the raw materials.

CONCLUSION

Basing on the previous researches in the field of monopolistic market functioning and study of pricing peculiarities in the monopoly, the authors of the paper have elaborated a formula of price for a product which is the primary raw material for chemical products. The proposed formula is based on the price for the final chemical products which is formed at a perfect market basing on the demand and supply, as well as on design factors that take into account the industrial level of profitability (profit margin), and direct costs that are taken into account in production of the final chemical products (processing cost).

The proposed formula takes into account both the cost method and market approach to price formation and secures at that the economic balance (of achieving the equilibrium profit margin) both for the buyer and seller of the product.

Thus, the specified scientific research of the authors in the field of product pricing under conditions of a monopolistic market in contrast to the available classical approaches showed that using the scientifically justified methods of product pricing makes it possible to achieve the balance of economic interests of the market participants by way of profit maximization as a result of activity of economic entities.

RECOMMENDATIONS

Such researches can be useful for the enterprises and companies that produce chemical products based on the primary raw material – ethylene. Under conditions of an antimonopoly regulation

of prices for products the chemical and petrochemical companies can use the proposed formula of ethylene price calculation.

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