

# The Fight to Overcoming Greenhouse Effect for Anti Global Climate Change and Current Situation

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## Abstract

*The greenhouse effect is caused by CO<sub>2</sub> released from various industrial and agricultural sources. Now assumed that, If we treat about 50% of the global greenhouse emission gases, global warming is considered to be remedied, while half of the total greenhouse gas emissions are nearly equal to the total emissions of greenhouse gases. From all thermal power plants. So if we treat all the exhaust gases from all thermal plants, global warming is considered to be remedied.*

*So far, the greenhouse effects have not been treated yet. In our opinion, There are four reasons for this situation, that is:*

- 1- We do not have a new generation of suitable industrial equipment and no suitable technologies*
- 2- We cannot remove the dust thoroughly before CO<sub>2</sub> separation from the exhaust gases.*
- 3- We have used ethanalamine to CO<sub>2</sub> separation from industrial emissions,*
- 4- We do not have the suitable solution to bury CO<sub>2</sub> on the ocean floor.*

*The authors of this project have overcome all the disadvantages mentioned above by proposing new generation of suitable new equipment as well as proposing new no-waste technologies suitable for treatment and reusing industrial exhaust gas as well as CO<sub>2</sub> separation out of it, proposed using a cheap solvent called soda instead of ethanalamine to remove carbon dioxide from industrial emissions, suggests two inexpensive solutions to bury carbon dioxide in the ocean floor.*

*The author has designed some major industrial equipment with a sufficiently large scale to handle industrial emissions of 3.4 million m<sup>3</sup> per hour from a fossil fuel-fired 1,000MW plant.*

*Industrial processes from very costly processes have many unreasonable steps have turned into less expensive industrial processes, even profitable.*

*Content of the project is represented by 27 exclusive patents VN, 23 of these inventions were participated in the international invention innovation competition in Toronto Canada in 2017, and all 23 proposals are awarded with 15 gold medals and 8 silver medals.*

*The project concludes with the following conclusions:*

- 1. Conclusion on the generation of the suitable new equipment.*
- 2. Conclusion on the suitable new technologies.*
- 3. Conclusion on the two stages for the treatment of industrial exhaust gases.*
- 4. Conclusion on the CO<sub>2</sub> separation from the industrial emissions and CO<sub>2</sub> transportation storage.*
- 5. Conclusion on the CO<sub>2</sub> storing on the deep ocean.*
- 6. Conclusion on the economic efficiency.*
- 7. General conclusion.*

## The Current Situation of the Fight against Global Climate Change

Because of the heat-absorbing effect of greenhouse gases such as CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, O<sub>3</sub>, organic fluoride compounds, the temperature of the Earth has been heating up, exceeding the allowable limit, causing the greenhouse effect. How much suffering will come to

man? If we do not timely handle the greenhouse effect, by treating greenhouse gases to a certain concentration that exists in the Earth's atmosphere, then humanity will be standing under the tragedy. After more than 30 years of research, we have been able to confirm that the greenhouse effect can be completely overcome.

The main cause of the global warming effect is the CO<sub>2</sub> from industrial emissions, combustion process from thermal power plants and the factory produces building materials using fossil fuels such as coal, diesel, natural gas CH<sub>4</sub>. From these plants, over 70% of the global greenhouse effect has been generated. Even according to the author, the amount of CO<sub>2</sub>, which causes the greenhouse effect, escapes from sources of energy that account for 82.3% in which more than 40% are released from fossil-fuel power plants. [1-3]. At the moment it is said that If global greenhouse gas emissions are reduced by 50%, the current warming of the earth will be overcome. This means that if we treat industrial emissions from fossil-fueled thermal power plants, the greenhouse effect will likely be remedied.

In 1930, a technology was announced to separate carbon dioxide from industrial emissions with M-ethanolamine [3]. a half century ago, textbooks have been written to teach students the separation of gases such as CO<sub>2</sub>, SO<sub>2</sub>, NO<sub>2</sub>, H<sub>2</sub>S from the gas mixture by chemical methods with M, D, T Ethanolamine, or Soda solution (Na<sub>2</sub>CO<sub>3</sub>) in water, that is the scientific basis for the separation of gases above, known long ago [4]. For more than 30 years, the process of separating these gases from the industrial emissions has been intensified. Today, MDT-Ethanolamine is still considered the best solvent for CO<sub>2</sub> removal from industrial emissions.

The method of using water solvents containing (M,D,T)-Ethanolamine to separate CO<sub>2</sub> from industrial emissions, has many disadvantages, and maybe so, for more than 80 years, humans have not possible industrial processes for the treatment of industrial emissions from large scale thermal power plants.

There are many researches to find alternative solutions to Ethanolamine to handle industrial emissions, but the results are still not able to solve the problem we expect.

In 2007 Billionaire Richard Branson launched the \$ 25 million prize for a commercializing listen project capable treatment for greenhouse gas to increase global climate sustainability (<http://www.virginearth.com/terms.html>). As we know, only a half of all global greenhouse gases are lost, global warming is treated, half of global greenhouse gas emissions are equivalent to the total amount of greenhouse gases by all thermal power plants. In sum, the billionaire Richard Branson proposed to find a viable solution that could commercially process greenhouse gas emissions from all thermal power plants.

The contest ended with thousands of proposals without the winner. The contest has been running for six years, and until today there is no solution for the competition. This raises the perception that it is impossible to handle greenhouse gases from all thermal power plants, in other words it is not possible to use fossil fuels to produce electricity if it is to protect the global climate. Therefore, every year at the international conference against global climate change is focused on eliminating fossil fuels and the need to produce electricity with renewable energy. Many countries advocate the elimination of fossil fuel power plants, and will develop 100% renewable energy.

Why so far, the people are not possible to thoroughly treat greenhouse gas emissions from large fossil fuel plants? According to the author, because the exhaust gas is too large (As today, no power plants with CO<sub>2</sub> - capture have been realized) [5].

On our opinion, it is four reasons, and also four disadvantages that we have not been able to do so far.

### **The First Reason also the First Disadvantage: This is the main reason, because we do not have yet suitable new generation of equipment, as well as suitable new technologies**

In many technologies, for example in multi-cyclones are used to separate dust [6]. According to, the complete cyclone can collect 96.5% of the dust contained in the exhaust gas [7]. If optimum linear velocity is 20m/s, each cyclone has a capacity of 500 m<sup>3</sup> /hr. For the emissions of 3.4 million m<sup>3</sup> per hour from the 1000MW thermal power plant, we have to use the 6800 cyclone single operate in parallel, in that time, for coal dust released from the thermal power plant Classic dust separators are not suitable [8].

Similar to the cyclone, industrial reactor with the stirrer have a limited diameter of about 4 meters with a cross section of 12.5 m<sup>2</sup>. Thus, to treat the exhaust gas of 3.4 million m<sup>3</sup> / h from the 1000MW thermal power plant, we need 560 equipment, operating in parallel.

Obviously with these types of classic equipment, the surface of the exhaust gas treatment plant will expand, and will be much larger than the factory floor itself. This will make the investment budget increase many times, compared with the investment cost of building a thermal power plant, the cost of electricity will be so high that no one can bear, not only 33-70% as the authors [9,10] warned. However, the dust released from the thermal power plants, the classic cyclone is completely no separate, meaning that we do not have the dust separator needed today.

Here I am talking about the device, the problem is much more important, is the technology problem. In all the typical technologies, there is hope for commercialization in the near future. People are not interested in treatment and reusing dust in the exhaust gas [3,6,11,12]. Thus, only the no-waste technologies can be satisfy our requirements. Unfortunately, so far, the technology has been researched and applied are the technology with many wastes.

### **The Second Reason also the Second Disadvantage Because we have not been able to handle dust thoroughly from industrial emissions before CO<sub>2</sub> separation**

Currently in all the technologies announced to handle industrial emissions, people do not put the need for thorough industrial dust disposal from the exhaust gas stream, because it unable to execute with modern industrial equipment, especially the coal dust emitted from thermal power plants, this dust will make the solvent, used to separate CO<sub>2</sub>, is MDT Ethanolamine, perishable.

### **The Third Reason also the Third Disadvantage Using solvent M, D, T-Ethanolamine to CO<sub>2</sub> separation from industrial emissions**

M,D,T Ethanolamin has many disadvantages in CO<sub>2</sub> separation from industrial emissions.

#### **First Disadvantage**

Ethanolamine is very expensive, 30 times more expensive than some cheap solvents such as NaOH or Soda. Also document says that NaOH or Na<sub>2</sub>CO<sub>3</sub> can completely do the function of the amine solvents above [4].

### The second Disadvantage

That is, not only CO<sub>2</sub>, but other acid oxides such as SO<sub>2</sub>, NO<sub>x</sub>, H<sub>2</sub>S, also participate in the complexed reaction with ethanolamine. That is, when we execute the thermal decomposition, apart from CO<sub>2</sub> we also obtain other acid oxides, even H<sub>2</sub>S. So the CO<sub>2</sub> obtained by this method is very dirty and toxic. If we want to use it for different purposes, such as food industry, or to store in the ocean floor, we must clean it.

### The Third Disadvantage

The anion impurities in the amine absorber that are easy to attach with the amine, forming heat stable salts, these heat-resistant salts, will break down the operating mode of the adsorption process, which consumes quite a lot of solvent, and the solvent regeneration for the reuse is quite complex, making the investment in CO<sub>2</sub> separation technology in this method is too large [13-15].

### The fourth Disadvantage

Ethanolamine is easily involved in the oxidation reaction with oxygen that exists in the exhaust gas. On the other hand, since the dusts present in the exhaust gas are not completely separated, they can also carry out different chemical reactions with the ethanolamine, the activity of the ethanolamine solvent degrades, consuming more.

Because these disadvantages that CO<sub>2</sub> costs are quite high, and in the whole cycle of emissions treatment, including CO<sub>2</sub> separation, CO<sub>2</sub> transport, and the bury of CO<sub>2</sub> to the ocean bottom, the CO<sub>2</sub> collection alone accounts for over 70% of total costs [16]

Probably because of the above reasons, the Amine method was found in the 1930s, there were hundreds of factories using the Amine method to CO<sub>2</sub> separation, but when setting problem to process Emissions from large power plants, the Amine method is not suitable [3].

### The Fourth Reasons also Fourth Disadvantage

#### The collection, storage and transportation of CO<sub>2</sub> as well as burying it to the ocean bottom is too expensive and unreasonable

According to, the total cost of handling 1T carbon dioxide, including the cost of CO<sub>2</sub> separation from industrial emissions, followed by CO<sub>2</sub> cleaning, CO<sub>2</sub> liquefaction, the cost of pumping CO<sub>2</sub> into the pipeline through the sea to the CO<sub>2</sub> storehouse, the cost of pumping CO<sub>2</sub> into the ocean floor is [16].

Total \$ 40.7-72 / TCO<sub>2</sub>

Alone the separation of CO<sub>2</sub> from the exhaust gas In clean gas state (no liquefied) accounts for more than 70% of the total cost. CO<sub>2</sub> after collection, it must be liquefied under pressure of 2000 psi, contained in high pressure, very heavy, and very expensive metal bottles. . Let's try to imagine that a medium-sized coal-fired plant, which uses about 1 million tons of coal each year, releases each year 3.7 million tons of carbon dioxide, all of which are liquefied, so we need a huge amount of high-pressure metal bottles, about 8 million tons, not to mention the four-stage compressor to liquefy CO<sub>2</sub>.

Thus, to treat the industrial emissions from thermal power plants to overcome greenhouse gases, we have to overcome these disadvantages mentioned above.

### Overcoming the Disadvantages of the Fight against Global Climate Change

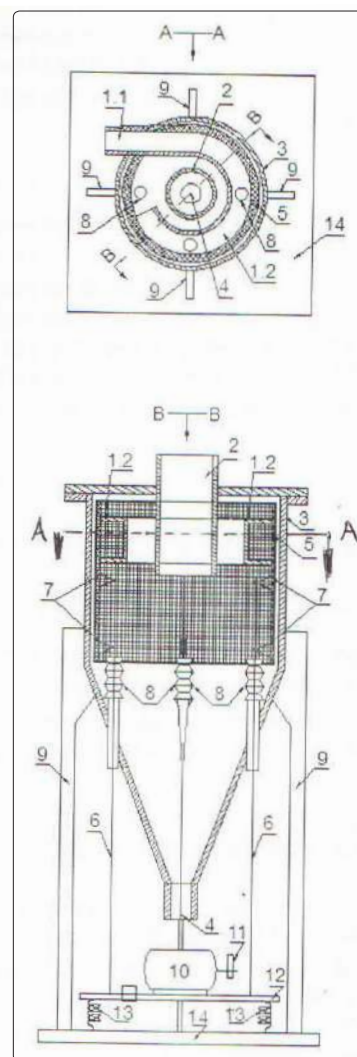
#### Overcoming the First Disadvantage this is Main Reason: Because we do not have yet Suitable New Generation of Equipment, as Well as Suitable New Technologies

##### Proposed the Suitable New Equipment

##### Proposed the new dust separators

##### The upgrading dry cyclone dust separator

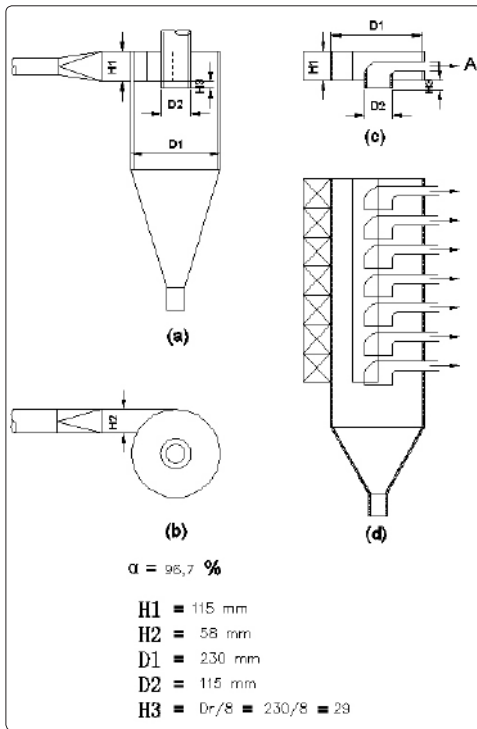
To overcome the disadvantages of the classical cyclone, we proposed dry and wet cyclone dust separators (see Figure 1) [16,17]. The machine was upgraded as follows. On the inner surface of the cyclone covered with a layer of multi-layer mesh (5) as a trap for trapping dust, the air passage (1.1) extends up to 3/4 the diameter of the cylinder with a constant cross section, forming a tunnel overlays the mesh, which means that the dusty gas flow along this tunnel with almost constant velocity. This mesh is constantly vibrating, so the dust is not clogged and falls continuously, and in the end will be escapes out.



Drawing 1: Upgrading dry cyclone dust separator

##### The combined upgrading dry cyclone dust separator

The individual dry dust separator above has a small capacity, so to meet the large technology requirements, we have to combine it [19].



**Drawing 2:** A solution for combination of upgrade dry cyclone dust separator

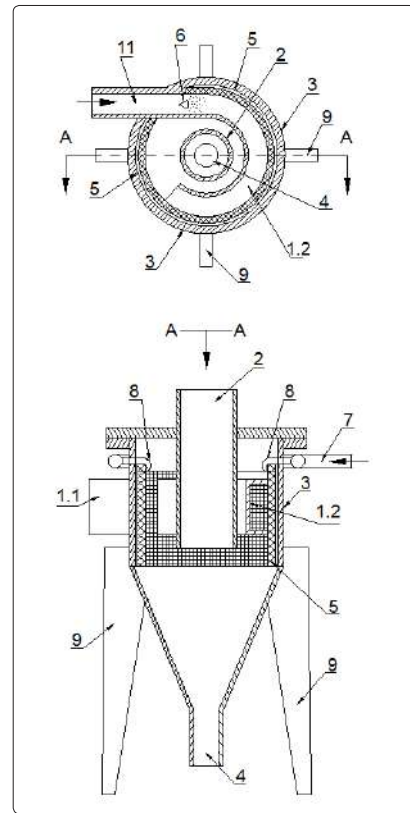
Figure 2 presents the combined solution of upgrade dry dust separator. The process is as follows. From Figure 2, we take the dust extract part of the classical cyclone (a), which is (c). Overlapping each other (c) we obtain a single sequence of the upgrade dry dust separator (d). It should be noted that in these combined upgrade dry dust separator the outflow of gas mixture after the dust extraction will follow on the exit pipe in the direction of the arrows A. Combination of some combined single sequences which operates in parallel we will have a complete combined upgrade dry cyclone dust separator.

### The upgrading wet cyclone dust separator

For separation ultra-fine dust as well as for the treatment of toxic chemicals as acid oxides we need an upgraded wet cyclone dust separator (see Figure 3) [18]. The upgrade process is similar to the upgraded dry dust separator. To neutralize the acids oxides present in the effluent stream, we put the stream of soda or solution (NaOH) flow into the cyclone continuously under pipe 7. From 7, there will be many small tubes 8 irrigated directly into the grid into cyclone. To lower the temperature quickly we use high-pressure misting nozzle 6 to ensure that the water vapor that is present in the exhaust stream can be condensed, which will cause the fine dust particles to separate from emission gases in the form of frost particles

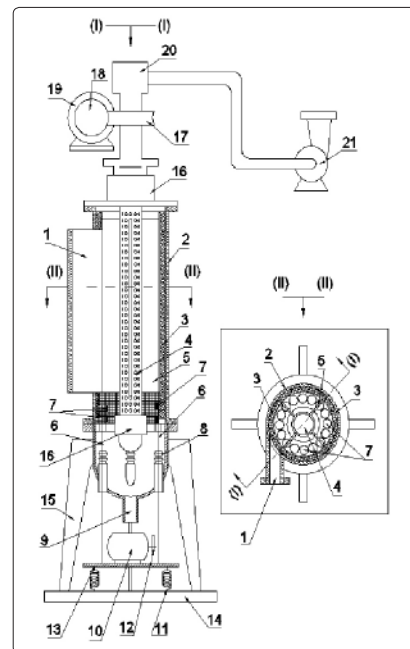
### The combined upgrading wet cyclone dust separator

The wet cyclone dust separator in a single state has a small capacity, in order to meet the large requirements of industry we need to carry out the combination of upgraded wet cyclone dust separator [20]. The combination process is the same as for upgraded dry cyclone dust separator.



**Drawing 3:** Upgrading wet cyclone dust separator

### The dry and wet centrifugal cyclone dust separator



**Drawing 4:** Dry centrifugal cyclone dust separator

The dry and wet cyclone dust separator has the following disadvantages:

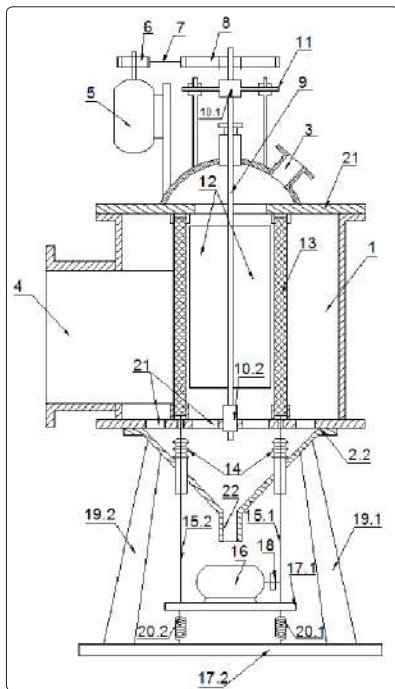
1-The require velocity of the inlet air flow must be optimal, so for unstable sources of exhaust gas is not suitable.

2-Centrifugal force, whereby the dust particles can be separated from the air stream, due the force obtained by the gas itself, not by the mainstream consciousness of man. By the way centrifugal force will be very small.

To overcome the above disadvantages of dry and wet cyclones, we propose the dry and wet centrifugal cyclones as shown in figure 4 [21,22]. All the measures used to upgrade dust separators we use to dry and wet centrifugal cyclone dust separators. The exhaust gas containing the dust is introduced into the machine, and this gas is subjected to extreme centrifugal force due to the centrifugal fan 4 located in machine center created. Dust particles must be separated from the gas will be have the great thrust of the centrifugal force. Nearly all of the dust particles are separated by a dry centrifuge dust separator, while the fine dust and toxic chemicals are separated by a wet centrifuge separator.

### 1.1.6 - The dry and wet Centrifuge filtered dust separator

In new machines, different centrifugal forces are used to separate the dust, in that time a very effective method of dust separation is dust separation by means of suitable filters that are not fully utilized in [17,22]. To overcome this disadvantage of, the machine we propose dry and wet filtered Centrifuged dust separator (see Figure 5) [17,22-24]. In this machine we also covered a multi-layer mesh on the inner surface of the cyclone. In addition, the filter 13 is placed in the center of the dust separator. The dust gases are deposited into the machine, and uniformly distributed onto the outer surface of the filter in the cyclone type. Dust particles will be separated by large centrifugal force due to centrifugal fan number 9 located in the center of the machine, Some of the remaining particles are retained by the filter membrane, because the membrane vibrates continuously, so the dust falls downward, and then goes out, and the gas mixture due to the small centrifugal force easy to cross the filter and out. Centrifugal filter dust separators also have two types, dry centrifugal filter and wet centrifugal filter.



**Drawing 5:** Dry centrifugal filter dust separator

### The dry and wet sinusoidal dust separator

Dust separation machines in the cyclone model have disadvantages, either dry or wet. In one machine can not satisfy the two requirements dry and wet [25]. That is, for a technology that needs dust separation, it must be used two machines are the same, one is to collect most of the dry dust, the other remains and the toxic chemicals, as well as the fine dust particles, we have to use a dust separator as above, but in wet form. To overcome all the disadvantages mentioned above, we propose a dry and wet sinusoidal dust separator (see Figures 6.7.8.9.10). The dust collecting mechanism in this machine is similar to that of the classic cyclone. In the classical cyclone, the device is cylindrical, so collisions between the dust particles and the cyclone can only occur once, while the wall of the device is sinusoidal may, so collide of the dust with the wall of the device many times, if we want to. On this sinusoidal surface we lay a multi-layered mesh with appropriate structure, which is a trap for dust storage. The machine has two parts that are dry and wet (Figure 8), the dry part can separate most of the dust, the rest is captured in the wet part of the machine, here the exhaust gas after the dry section retains the optimum linear velocity, mixed with the soda solution particles in the form of frost beads due to the special structure machine, this causes temperature of the exhaust gas to drop very quickly, moisture in the exhaust gas may condense, which facilitates the removal of very small dust particles left in the exhaust gas, which then comes in contact with the soda solution particles by the sprinklers are continuously watered, and finally the gas mixture and the liquid particles are directed to a thick layer of mesh to increase the contact surface between the two phases, the net also acts as a trap for collecting dust and liquid particles. in the air stream.

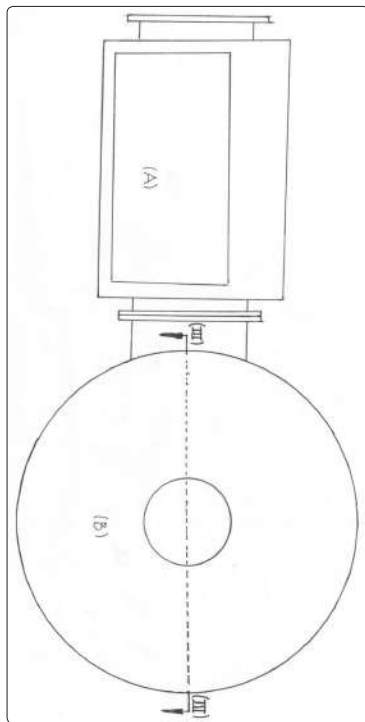
We first need to know how to create sine lines. The sine path is generated by the parabolic trajectory  $Y = X^2$ , the following table shows how the Y value in X is calculated. The value  $X = 115$  is the radius of the complete cyclone, which is determined by experiment [7].

The parabolic lines give the cyclone walls (see Figure 7). Industrial exhaust gas is introduced into the machine through the flange 1, the walls of the cyclone separated by a suitable distance, it is determined experimentally. The exhaust gas encounters the orientation plate 5 to force them into the grid 4 already available on the cyclone wall. This is the first collision, then come to the another half of the parabola, the emission stream, again meets with the orientation plate and again collide with the grid. So every sinusoidal cycle, the emission streams with the dust particles collide 2 times in the direction tangent to the cyclone. If the cyclone has 3 sinusoidal cycles, the dust particles have to collide 6 times with the cyclone. After the collision, dust particles are trapped by the netting 4, and will be seized, these grids continuously vibrate (see Figs. 8,9), causing the dust to fall down through the holes 6 of the floor 7 into the funnel 20, dust is recovered. Load screw 10 operates by electric motor 12 and gearbox 11. The vibration of the grid is as follows. The electric motor 16 has an eccentric wheel 17 on the shaft, which is located on the floor 18, which is hanging on in the lid 19 via the springs 15, and the lid 19 is positioned in the machine by the vertical columns 13. The floor 18 connects directly to the shafts 9 for connects with the grids 4. Thus, when the motor operates, it will vibrate continuously because of eccentric wheels 17. The floor 18 will vibrate, it makes the vertical shafts 9 pull along the 4 grids along the same vibration. To ensure the sealing of the vibration,

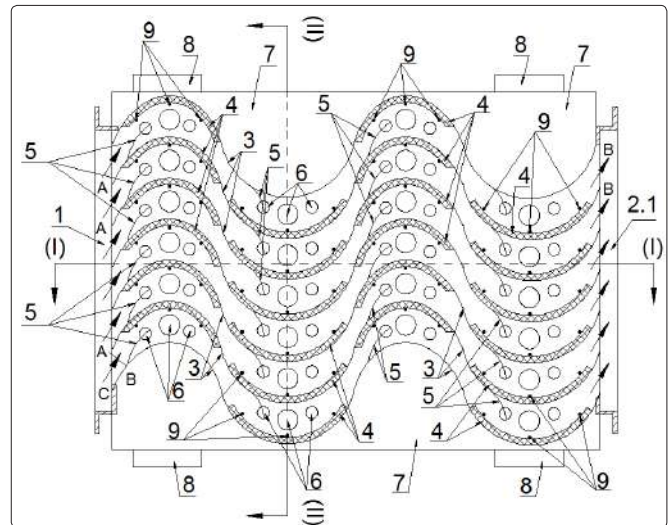
we connect the shaft 9 to the floor by the sinphones 14. Clean air flows out through the cap 2.1 (Fig. 7) to into the cap 2.2 (Fig. 10) at constant velocity to enter the wet portion B of the dust separator. The gas is directed downwards and out through the exit 23, where the gas stream is blended with a stream of mist from the nozzles 24 to cool down rapidly. The airflow continues downwards and is washed away by the soda stream provided by the nozzles 25, and finally, the gas stream incoming to the multi-layers grid 27 with the required height to finish the wash away remaining dust, as well as neutralize acid oxides in the industrial effluent stream.

Pump 26 pumps continuous flow of cold soda solution. Multi-layered mesh are located in brackets 28. Clean air flows out through the escape hole 29.

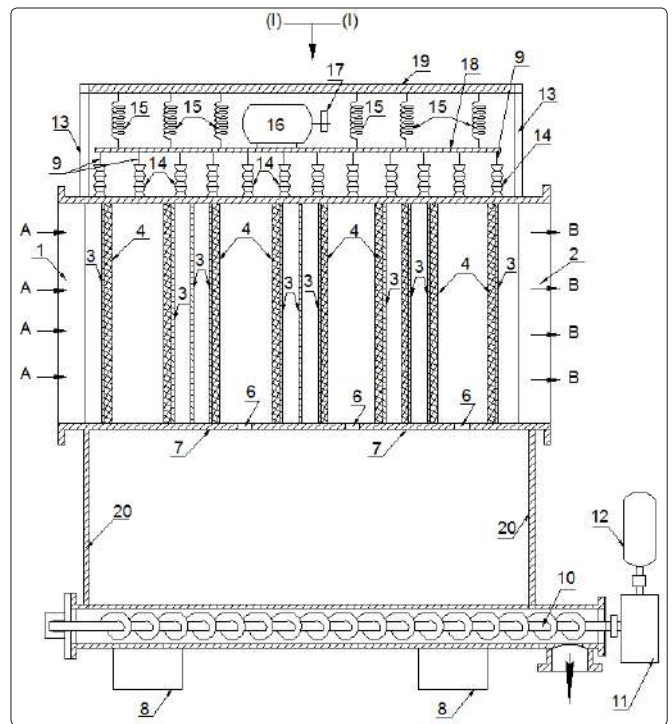
TT	X	Y	The real value of y (mm)
1	0,1	0,01	$115 \times 0,01 = 1.15$
2	0,2	0,04	$115 \times 0,04 = 4.6$
3	0,3	0,09	$115 \times 0,09 = 10.35$
4	0,4	0,16	$115 \times 0,16 = 18.4$
5	0,5	0,25	$115 \times 0,25 = 28.75$
6	0,6	0,36	$115 \times 0,36 = 41.4$
7	0,7	0,49	$115 \times 0,49 = 56.35$
8	0,8	0,64	$115 \times 0,64 = 73.6$
9	0,9	0,81	$115 \times 0,81 = 83.15$
10	1	1	$115 \times 1 = 115$



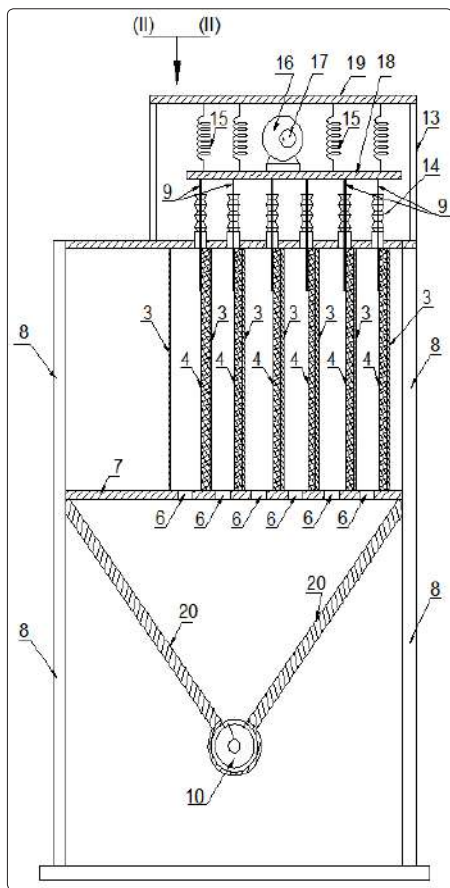
**DRWING 6:** Looking from the outside of sin road dust separator has two part A dry and B wet



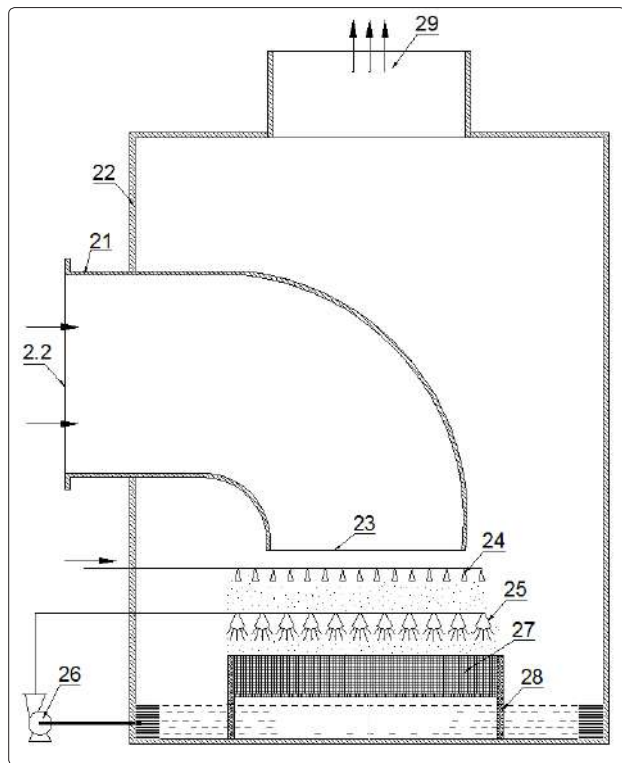
**DRAWING 7:** Cross section of the dry part of dry and wet sin road dust separator



**DRAWING 8:** Cross section I - I of the figure 37



**DRAWING 9:** Cross section II - II of the figure 37



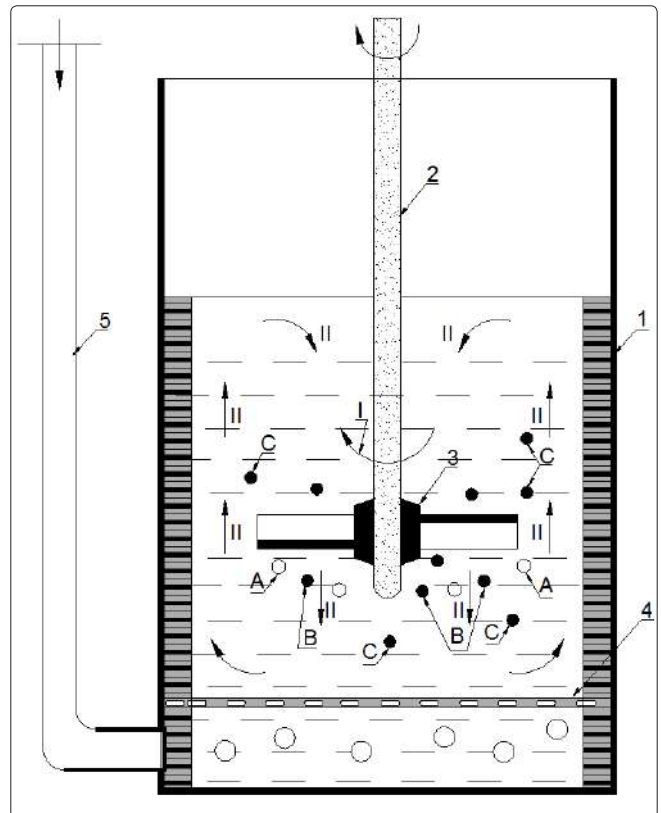
**DRAWING 10:** Section III - III dry part of the figure of 36 sine road dust separator

## Proposed New Solid Liquid Gas Heterogeneous Reactor (SLGHR)

### The interruption SLGHR

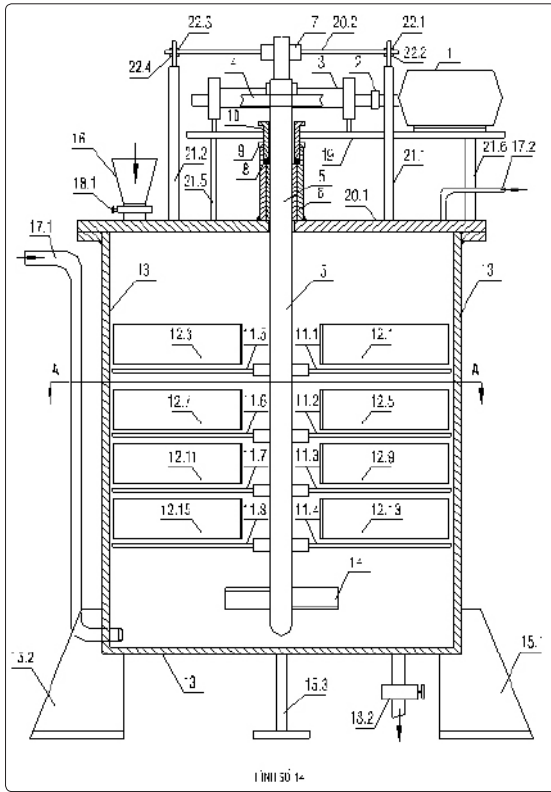
Figure 13 shows the classic SLGHR.

To perform the reaction between the A, B, and C constituents (see Figure 11) we must mix with the required velocity. The agitator 2 rotates, because it has a propeller structure, should the agitator produces two-way motion (see arrows) for all constituents in the reactor. Direction (I) is the rotation around of the stirring axis, while the direction (II) moves along the stirring axis. Such agitation makes the system quickly uniform. It is important to note that they move together, and if they move at the same speed, the relative motion speed between them is zero. Similar to when we go on a train, we and the train travel together at a very high velocity as compared to the ground, but the relative motion velocity between us and the train is zero. The disadvantage of classical SLGHR is that there is little chance of contact between the elements of A, B, C, so the chances of chemical interaction between them are not high. Not to mention how to hit the gas bubbles so that it must be splits into ultra-fine particles, the classical RLK cannot do. .



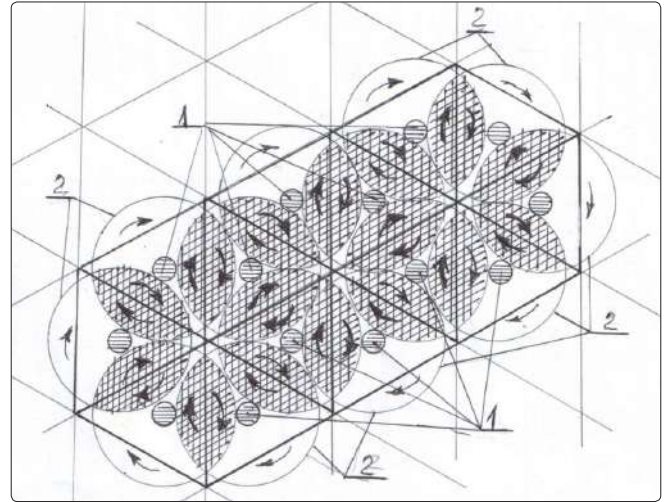
**Drawing 11:** Classic SLGHR

To overcome the disadvantages of the classical SLGHR, we propose new SLGHR (see Figures 12 and 13) [26]. In this device the liquid flow cannot be rotated around the stirring shaft because of the bumpers 12, while the gas mixture flows from the bottom upwards, passing through space between the resistant layers 12, flat stirring paddles 11 move very fast, hit the gas bubbles, create extremely small air bubbles, and the relative velocity between them is very high, create contacting opportunities between the two phases a lot.

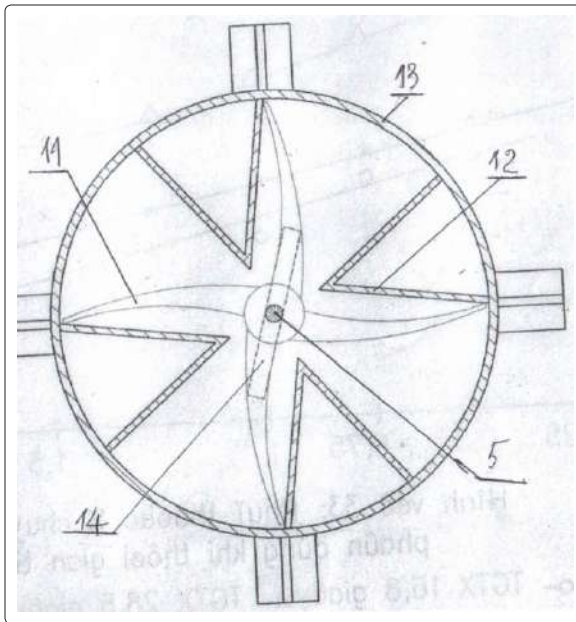


**Drawing 12:** interruption SLGHR

The following is a combination of the three interrupt SLGHR shown in figures 15 and 16. Follow picture 16 we see the zones with the two lines intersected, where the paddles have crossed twice in reverse direction, so suppress the circular motion of the fluid around the stirring shaft. So, bumpers 12 in figures 14 and 15 will be required for outer space, and the central area of the combined SLGHR is not necessary the bumpers. The number of individual SLGHR participating is not limited. Figure 17 shows the cross section of the 24 combined SLGHR according to the equilateral triangle principle.



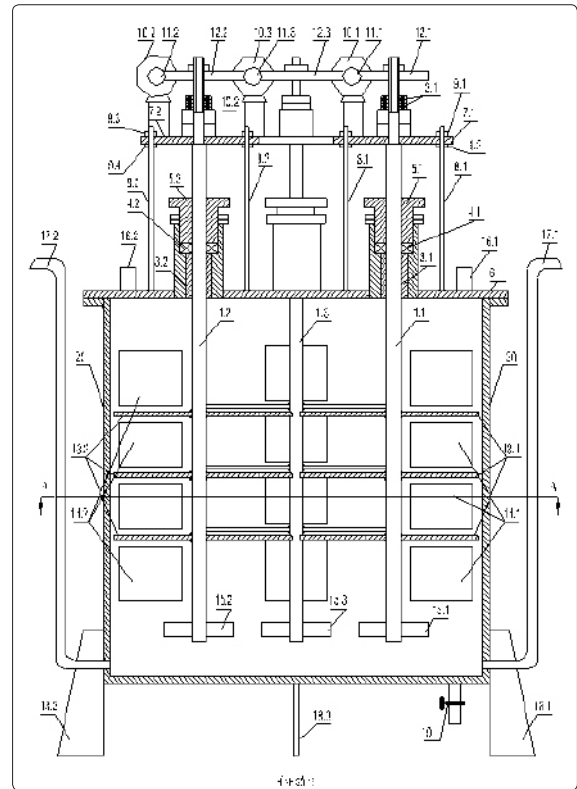
**Drawing 14:** Combination solution of SLGHR according to the equilateral triangle principle



**Drawing 13:** Cross section A-A of drawing 14

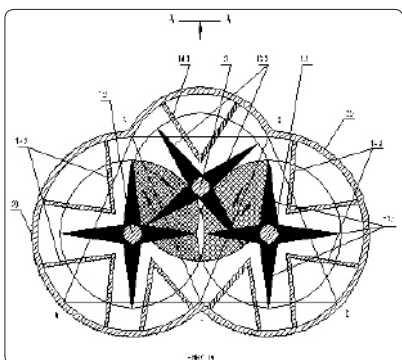
**The combined interruption SLGHR**

Individual Interruption SLGHR has a small capacity, to increase the capacity we have to combine, here we present the combined principle of equilateral triangles [27]. In figure 14 the equally adjacent equilateral triangles, whose centers are also the centers of rotary axis 1 of all individual SLGHR 2.

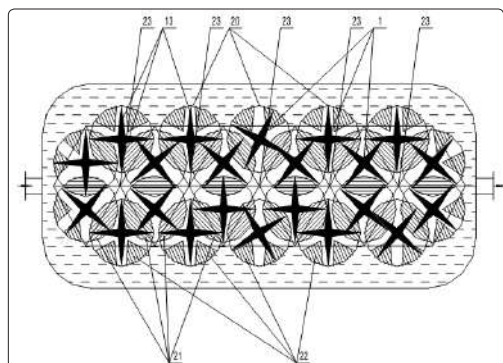


**Drawing 15:** Combination of 3 SLGHR according to the equilateral triangle principle





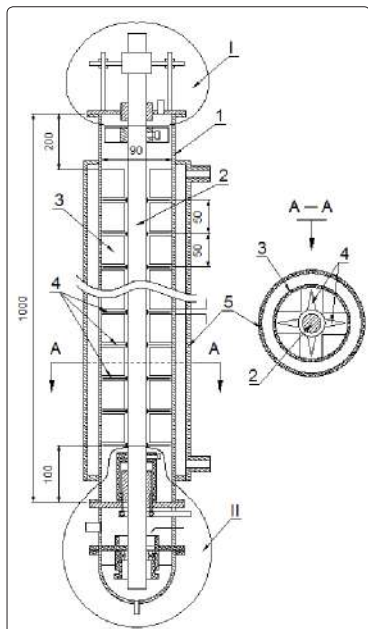
**Drawing 16:** Cross section A-A of the drawing 15



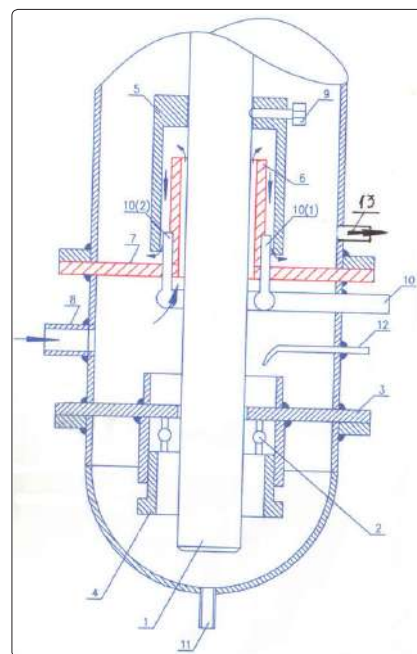
**Drawing 17:** combination of 24 individual SLGHR according to the equilateral triangle principle

### The continuous SLGHR

In the industry we need SLGHR continuous operation with extremely large capacity [28]. To achieve this we need to have a long stirring shaft, and rotate at a fairly large speed. However, in the present industry it is not possible to do, as the stirring shaft is usually only located with a ball bearing at the top, and the bottom because it is in the liquid, so it cannot be attached ball bearing. We have proposed appropriate solution to overcome the above disadvantage



**Drawing 18:** Continuous SLGHR



**Drawing 19:** Bottom II of the continuous SLGHR

Figure 18,19 presents the SLGHR in continuous operation [23]. We create a small compartment at the bottom by divided plate 7 (see figure 19). Air from the outside into the tube 8 then travel along the gap formed between the outer surface of the shaft and the inside surface of the tube 6, Because the grabbed pipe 5 the gas stream should move down to enter the reaction zone (see Figure 19). Thus, the lower compartment is usually dry and we can attach the ball bearing to the end of the shaft. In this way we get the continuous SLGHR.



Photo of prof. Nguyen Dan next to the experimental system with the product is the  $\text{NaHCO}_3$  crystals obtained from the following reaction  $\text{CO}_2 + \text{Na}_2\text{CO}_3 \rightarrow \text{NaHCO}_3$  When using continuous SLGHR [28].

### The combined continuous SLGHR

Individual SLGHR has a small capacity, to meet the requirements of industry, such as the need to treat  $3.4 \text{ million m}^3 / \text{hour}$  of exhaust gas from a  $1000 \text{ MW}$  coal-fired power plant [29]. As we have discussed in Section 1.2.2, we have succeeded in designing a combined continuous SLGHR with a 1062 of single SLGHR having a cross

section of 9444 m<sup>2</sup> to CO<sub>2</sub> separation from the 3.4 million m<sup>3</sup> / h gas stream of the 1000 MW coal-fired power station [8].

### Proposing the New No-Waste Technologies for the Thorough Treatment Dust and CO<sub>2</sub> Separation from Industrial Exhaust GAS

#### The New No-Waste Technology for Treatment and Reuse Industrial Exhaust Gas

There are hundreds of new technologies available for the treatment of industrial exhaust gases, which can be said that all these technologies have been applied, or have not yet been deployed in industry, have the following disadvantages;

These are technologies with the wastes, and do not make use of waste in the industrial emissions stream, for example, as dust is present in the exhaust stream.

These technologies generally have not enough capacity to handle industrial emissions from large power plants of thousands of MW, so they do not help us solve the problem of overcoming the greenhouse effects against global climate change.

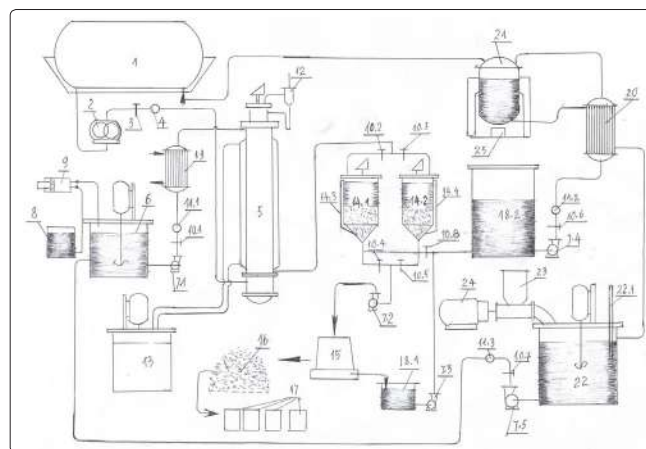
In order to overcome the above weaknesses, we have proposed a new technology, which is no-waste technology. That contains in the industrial exhaust gases, such as dust, nitrogen gas, CO<sub>2</sub>, these wastes can collect and reuse, the technology can be deployed on a large scale to handle industrial emissions from the all plants using fossil fuel.

For the presentation of the technology I would like to make an appointment with you on the next section of the report.

#### Overcoming Second Disadvantage New No-Waste Technology for CO<sub>2</sub> Separation from Industrial Exhaust Gas in the Kind of Moisture Powder NaHCO<sub>3</sub>

Technology works as follows (see drawing 20) [30]. Industrial waste gas after it has been thoroughly treated to remove dust and eliminate toxic acid oxides, are contained in one bag 1. Emissions from there it is pumped 2 through valve 3 to adjust the flow and then to velocity meter 4, and finally pump into the bottom of GLSHR 5 to conduct a chemical reaction with soda solution is available in 5. Remaining gas after the reaction escaping through the cyclone 12 in order to collect the liquid entrainment

Technology works as follows (see drawing 20) [30]. Industrial waste gas after it has been thoroughly treated to remove dust and eliminate toxic acid oxides, are contained in one bag 1. Emissions from there it is pumped 2 through valve 3 to adjust the flow and then to velocity meter 4, and finally pump into the bottom of GLSHR 5 to conduct a chemical reaction with soda solution is available in 5. Remaining gas after the reaction escaping through the cyclone 12 in order to collect the liquid entrainment



**Drawing 20:** New No-Waste Technology for CO<sub>2</sub> Separation from Industrial Gases in the Kind of Moisture Powder NaHCO<sub>3</sub>

Soda solution was continuously led to 5 as follows. Machine 6 to mix a 20%WP soda solution with the Catalyst, from here by liquid pump 7.1, it pumps through control valves 10.1, velocity meter 11.1, then the heat exchanger 19 to maintain temperature 40°C of solution flow [30]. Soda solution mixed with a catalyst solution is directed into the top of GLSHR 5. The reaction product is the solution containing NaHCO<sub>3</sub> precipitate sludge from the bottom 5 overflowed continuously into 2 decantation devices 14.1 or 14.2. These devices work interruptions, alternately each other, they are equipped with mixer to prevent the ability to create precipitate in the bottom of the device. Start, for example, the product containing precipitated residue NaHCO<sub>3</sub> through the valve 10.2 overflow continuously into 14.1, as well monitor liquid level by device 14.3 when we know the liquid is fulling in 14.1, lock the valve 10.2, and open the valve 10.3 to product flowing through 14.2. We monitor the NaHCO<sub>3</sub> precipitate residue in 14.1, when the sediment was deposited stable, we will open the valve 10.4, and put pump 7.2 to working to pump the sludge from 14.1 to interruption decantation centrifugal machine 15 [36]. From 15 we get the product moisture powder NaHCO<sub>3</sub> contained in the bag 17, the liquid after 15 will be stored temporarily in a tank 18.1, then thanks to pump 7.3 injected into storage 18.2. After the precipitated residue in 14.1 has been pumped to the 15, the liquid remaining in the tank 14.1 are removed through 18.2. The transparent liquid after the deposition of sediments will be contained in the 18.2, in this solution still contain NaHCO<sub>3</sub> dissolved, this NaHCO<sub>3</sub> soluble portion has an adverse effect on the reaction between CO<sub>2</sub> and soda solution, if it was not heat treated. The process is conducted as follows. Liquid pump 7.4 will pump this liquid from the tank 18.2 through the control valve 10.6 velocity meter 11.2 followed by heat exchanger 20, to raise the temperature of the liquid flow from 40°C to 80-90°C by hot soda solution line running from the thermal decomposition furnace 21. After 20, the solution will flow into the thermal decomposition furnace 21, where the NaHCO<sub>3</sub> soluble portion will decompose to CO<sub>2</sub> will be stored in bag 1, and fluid flow is soda solution overflowed continuously through 20 and stored in the tank 22, where it is produced 20 %WP soda solution.

Soda powder materials contained in bunker 23, loading screw and motor 24 will push continually soda to 22, thanks to hydrometer 22.1, by which we can observation the process of preparing the soda solution for the technology. Standard soda solution from tank 22 is pumping by the pump 7.5 through the control valve 10.7, speed

meter 11.3 to device 6 for mixing with catalyst.

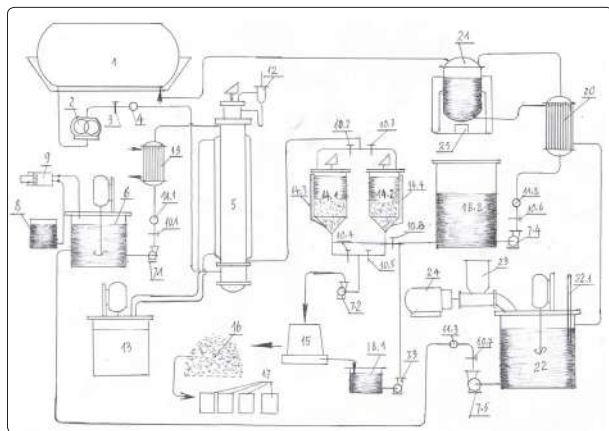
### Reaction temperature of 40°C was maintained by automatic thermostat 13. Heat load is pumping into the casing of GLSHR 5.

The New No-Waste Technology for CO<sub>2</sub> Separation from Industrial Exhaust Gas when Final Product is Clean Liquid CO<sub>2</sub> or Dry Ice Technology works as follows (see figure 21) [31]. Industrial waste gas after it has been thoroughly treated to remove dust and eliminate toxic acid oxides, are contained in the bag 12.1. Gas from there is pumped by screw pump 8, to the control valve 9 velocity measure 10 and final is introduced into bottom of the GLSHR 6 to carry out chemical reaction with soda solution is available in 6. Gas after 6, get out through cyclone 17 to withdraw liquid entrainment. Soda solution is led to 6 as follows. 20 % WT Soda solution from tank 1.1, thanks the liquid pump 2.1 will pump through control valves 3.1, speed gauge 4.1, then the heat exchanger 13.4 to maintain temperature 40° C of fluid flow, followed will be meet with the catalytic solution, this solution is pumped from the tank 7, which is pumped by pump 2.2 through control valves 3.2, gauges velocity 4.2. Soda solution mixed with a catalyst solution then are directed into the top of the GLSHR 6. Reaction product is solution containing NaHCO<sub>3</sub> precipitate, overflowed continuously from the bottom 6 overflows through funnel 5, then enters into the heat exchanger 13.3, to here the hot soda solution at the temperature of 100-102°C is pumped 2.4 pumping in, will heat the solution stream containing precipitated NaHCO<sub>3</sub> in the device 13.3, the precipitation temperature is raised to about 60°C, and the process of thermal decomposition occurs



Carbon dioxide obtained after passing through reverse refrigerator 13.1 will be collected in air bag 12.2. After 13.3, the remaining solution after decomposition still contains a portion of dissolve NaHCO<sub>3</sub>, liquid pump 2.3 will inject directly into rotary kiln 14, The heat in the rotary kiln is maintained at 102-103°C, which is the boiling point of the 20% WP soda solution [32]. From the furnace 14 the CO<sub>2</sub> flows out and after pass the reverse refrigerator 13.2, enters the gas bag 12.2, the hot soda solution, which flows out continuously and contains in the reservoir 1.2, from which liquid pump 2.4 will pump into the Heat exchanger 13.3 [32]. Finally the recycled soda solution will be stored in the original raw material tank 1.1 contains 20% WP soda solution.

The 4-stage high-pressure pump 15 draws CO<sub>2</sub> from the air bag 12.2 and liquefy the CO<sub>2</sub>, which is stored in high pressure metallic bottles 16 or can be turned into dry ice contain in the suitable packaging.



**Drawing 21:** No - waste Technology for collecting CO<sub>2</sub> from industrial effluents in the form of food clean liquid CO<sub>2</sub> or dry ice

### Overcoming Second Disadvantage: Because we have not been Able to Handle Dust Thoroughly from Industrial Emissions before CO<sub>2</sub> Separation

If it is required to thoroughly treat the industrial dust contained in the industrial exhaust gas, and see the dust as the primary raw material for the production of industrial products, no technology has been declared satisfactory [31]. The whole operation of the no-waste technology is shown in Figure 22 and operates as follows.

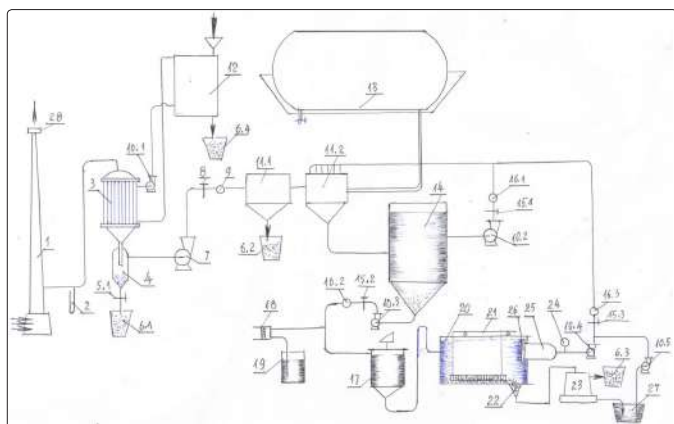
Exhaust gases from power plants escape outdoor through chimney 1. Using gas pump 7 to suck emissions from the chimney 1, then pass through a heat recovery machine 3, coarse dust is collected in 4. Exhaust flow is directed through the control valve 8, velocity meter 9, followed to dry dust separator 11.1 [17,19,21,23], to be able to collect almost of the dust in the exhaust stream. The remaining fine dust and toxic acid oxides to handle by the wet dust separator 11.2 [18,20,22,24]. In this, the line of soda solution or NaOH is pumped up from pumps 10.2 and 10.4, through flow control valves 15.1, 15.3 and speed meters 16.1 and 16.3. Clean waste gas is recovered after 11.2, will be contained in the bag 13. Fluid flow contain dust is flowing directed into the tank 14, Sediment will settle down to the bottom of 14, which is pumping by the pump 10.3 for processing and reuse.

Gas suck pump 7 will suck emissions from the chimney 1, we increase capacity of the pump 7, so, exhaust velocity gauge 28, located at the top of the chimney 1, gradually reduced to zero. That is now the whole exhaust no longer escaping from the chimney 1.

Regeneration process fluid obtained from tank 14 occurs as follows. Liquid pump 10.3 will pump precipitate residue through control valve 15.2, then the velocity meter 16.2. Sediment stream will meet with flocculation line may be PAC, which is pumped up by the metering pump 18, the mixture will be mixed in 17, and overflow continuously to the continuous filtration and decant flocculation tank 20 [33]. Here, the precipitate sediment will settle to the bottom of the tank, and one way rake 21 raking and collect into the gulf 22, from here, the resulting residue stream is leading continuously to centrifugal decantation machine 23, from 23 we obtain moist dust contained in 6.3, then use the dryer 12 for drying, and transparent solution after 23 will be provisional storage in barrel 27, from here pump 10.5 pumps to reused [34-37].

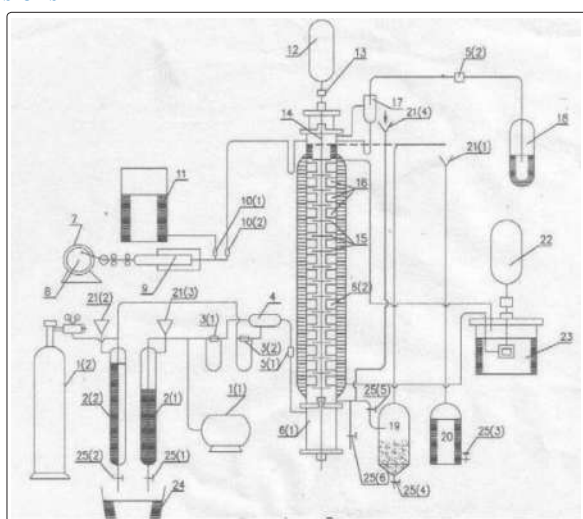
The fluid stream in the tank 20, after separating the residue will be filtered by the continuous filter 25, to filter out suspended solids in the tank. Pump 10.4 has two functions are the suck and repulsive is used to enhance the capacity of the filter 26. Here we installed vacuum gauge 24 to monitor the working status of the membrane 26. When the filter clogging, vacuum gauge 24 tells us, and rapid treat filtration membrane, that technological process does not have to stop [38]. The liquid is used in tank 20 as soda or washy lye, depending on the require of the treatment process. To ensure stable levels of alkalinity, pH meter was used, and the system provides soda or washy lye.

Above is no-waste technology, the dust in the exhaust gas stream is completely recovered, and is considered as a material to make fillers in the industry of processing rubber or plastics of all kinds, CO<sub>2</sub> was recovered by the use of new no-waste technologies, the remaining gas is essentially N<sub>2</sub>, separated to produce ammonia [30,31].



**Drawing 22:** No-technology for treatment and reuse industrial exhaust emissions

**Overcoming Third Disadvantage: Because we use M,D,T-Ethanolamin Solvent to CO<sub>2</sub> Separation from Industrial Emissions**



**Drawing 23:** Experimental system for studying the chemical reaction between CO<sub>2</sub> and soda solution using continuous new SLGHR

We have listed four disadvantages of Ethanolamin solvent in its use to remove CO<sub>2</sub> from industrial emissions. So we have to study replace it with another solvent [39]. To do this, we have to study. The work was conducted according to experimental system 23 with the following directions

**1-Research using new continuous SLGHR [23] to implement the reaction**



Evaluation results of the best of the new GSLHR are listed in Table 1

**Table 1: Results of the study for evaluate the best of new continuous SLGHR**

Regime	% Conversion of CO <sub>2</sub> on the time (h)				
	0.5	1	1.5	2	medium
No stirring	17.41	16.77	15.48	14.2	15.96
Stirring	77.15	79.47	80.8	80.2	79.4

Here we see the % CO<sub>2</sub> conversion in the reaction between CO<sub>2</sub> and soda solution, increased from 15.96%, when not stirred, to 79.4%, when stirred. So thanks to the stirring with special structure of the continuous new GSLHR, the % conversion of CO<sub>2</sub> has increased by nearly 5 times [28]. So from here we will use the continuous new SLGHR to conduct research to ethanolamine replacement with soda to separating CO<sub>2</sub> from industrial emissions.

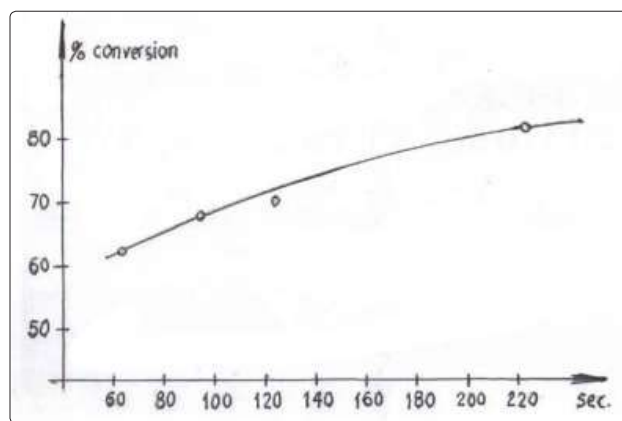
1- Determine appropriate retention time when CO<sub>2</sub> initial concentration is 15%VL under the following conditions:

1. 40°C reaction temperature.
2. Flow rate of 20%WT soda solution is 15 gr. / min.
3. Air flow rate 2.45 l / min.
4. CO<sub>2</sub> flow rate 0.45 l / min.
5. Concentration of CO<sub>2</sub> into the device 15% VL.

The results of the experiment are listed in Table 2 below, and are shown in Figure 24. Here we obtain the following important conclusion: retention time is suitable for the reaction between CO<sub>2</sub> and soda solution 20% TL is 220 seconds.

**Table 2: Results of the study the influence of retention time (sec.), when CO<sub>2</sub> concentration 15%VL**

No	Exp. dates	Retention time (sec.)	Quantity of soda (kg)	% conversion of CO <sub>2</sub> on reaction time (h)					
				1	2	3	4	5	6
1	8/10/2011	62	2.6	63.2	62.4	70.8	74	76.4	70
2	7/16/2011	83	4.7	70.7	70	72.1	68.57	67.85	
3	8/11/2011	93	3.7	71.75	80.91	77.48	76.33	77.86	78.62
4	8/9/2011	124.5	4.7	77.24	79.86	79.13	79.49		
5	8/13/2011	224	4.7	76.8	72.8	82.4	82.4	82	



**Drawing 24:** Depends of the % CO<sub>2</sub> conversion on the retention time of the reaction between CO<sub>2</sub> and soda solution.

**Research to find the catalyst for the chemical reaction between CO<sub>2</sub> and soda solution**

Recognizing that the retention time 220-second is too large and difficult to implement in the industrial process effectively, we hope to solve the problem by finding the appropriate catalyst [40]. After many years of research and we have found the catalyst needed for the chemical reaction. Following are some initial scientific and technological results.

Determination of appropriate retention time when use the catalyst Enca - 4 for reaction between CO<sub>2</sub> and soda solution (Enca is a name of the catalyst with the meaning of environmental catalysis).

The experiment was carried out according to the following conditions

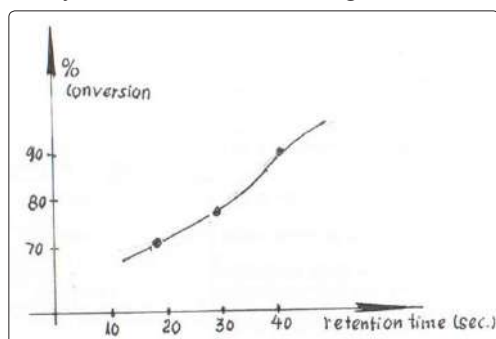
1. Reaction temperature: 40 °C
2. Air flow rate 4.21 / min.
3. CO<sub>2</sub> flow rate 0.25 l / min.
4. Concentration of catalyst EnCa - 4 : 1/1000.
5. Concentration of CO<sub>2</sub> into the device 15% VL.

The results are listed in the table 3, and represented by the figure 25

**The Table 3. Experimental results the catalyst effects on the retention time of reaction**

No	Exp. dates	Retention time (sec.)	Amount of Soda (kg)	% conversion of CO <sub>2</sub> on reaction time (h)					
				0.25	0.5	0.75	1	1.5	2
1	11/2/2011	16.8	2		71.11	70	64.44		53.33
2	11/2/2011	28.8	3	78.89	78.89	73.33	70	67.78	68.89
3	11/4/2011	40.8	4	94.79	90.62	86.45	83.33	78.64	77.08

From the above figures, we see, thanks the EnCa -4 we can achieve % conversion of CO<sub>2</sub> to 95% when retention time just 41 seconds, during which, in the absence of catalysts, we can achieve% conversion of CO<sub>2</sub> 82% with retention time 224 seconds. Productivity can be increased nearly six times thanks the “magic wand” EnCa - 4.



**Drawing 25:** Depend of CO<sub>2</sub> conversion % on the retention time when initial CO<sub>2</sub> concentration is 15%VL and catalytic utilization.

**Overcoming Fourth Disadvantage: The Collection, Storage and Transportation of CO<sub>2</sub> as well as Burying it to the Ocean Bottom is too Expensive and Unreasonable**

Here are the necessary expenses for the treatment of industrial emissions in order to CO<sub>2</sub> separation [16]:

**1- Separation** – The range for the cost of capturing CO<sub>2</sub> from flue gas using amine absorption is Can ..... **\$ 30-50 per ton (t) of CO<sub>2</sub>**

**2- Compression** – After purification, the CO<sub>2</sub> is compressed, typically to 13.8 MPa (2000 psi) for pipeline delivery. It will require multistage compression with cooling between stages. This compression technology is quite mature and does not need further development for CO<sub>2</sub> compression. Typically, compression cost ranges from Can..... **\$8-10/t of CO<sub>2</sub>**

**3- Pipelining** - Pipelining CO<sub>2</sub> is a well-established commercial technology. The CO<sub>2</sub> pipeline can be laid using normal gas construction method. Pipelining cost ranges from Can .....

.....**\$0.7-\$4/tCO<sub>2</sub>/100 km**

Depending on construction terrain. Potential problems are pipeline corrosion and gas-liquid two-phase flow.

**4- Injection** – Injection of compressed CO<sub>2</sub> into geological reservoirs on land can be carried out with conventional drilling and well technologies. Pumping of CO<sub>2</sub> liquid is relatively inexpensive. Cost for the CO<sub>2</sub> injection will vary with well cost and reservoir injectivity. Typical cost ranges from .....

.....**\$2 to \$8/tCO<sub>2</sub>**

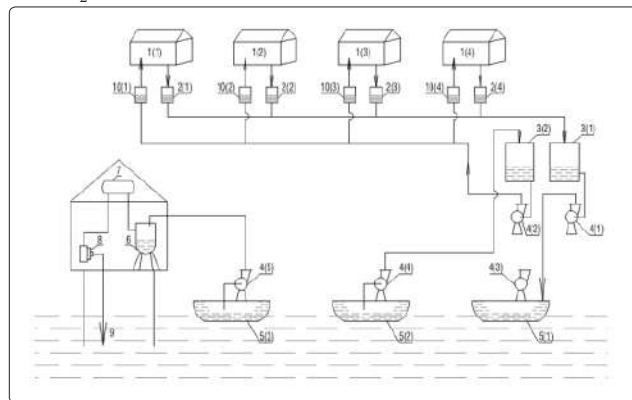
**A total of 40.7 to 72 USD/TCO<sub>2</sub>**

To overcome some steps listed above in the current solution, we have proposed two new solutions:

**First Solution: CO<sub>2</sub> Separation, Storage, Transportation Under the form of Powder NaHCO<sub>3</sub>, CO<sub>2</sub> will be Burial Under the form of Clean Liquid CO<sub>2</sub>**

See drawing 26. From the establishments of industrial exhaust gas treatment 1(1), 1(2), 1(3), 1(4), we obtained product is crystal NaHCO<sub>3</sub> in the aqueous solution, or wet powder NaHCO<sub>3</sub>, these products temporarily store in the containers 2(1), 2(2), 2(3), 2(4) [41]. Finally these products are transported to storage 3(1). From here thanks to the pump 4(1), NaHCO<sub>3</sub> suspension solution is pumped into the transport barge 5(1). Barge will carry this product to the open sea where necessary, to pump into the thermal decomposition system (6), CO<sub>2</sub> gas collected will be stored in gas bag (7) [32]. High pressing compressor (8) gives liquid CO<sub>2</sub>, and pump directly to the ocean bottom (9) for the storage. From the thermal decomposition system of NaHCO<sub>3</sub>, soda solution line continuously flows out, and stored in barge 5(2), then, this barge will transport to coast, and inject it into storage 3(2) of soda solution. From 3(2), pump 4(2) will pump the soda solution back, and temporarily stored in the tanks 10(1), 10(2), 10(3), 10(4) of the waste gas treatment bases 1(1), 1(2), 1(3), 1(4). Thus, we have completed cycle of CO<sub>2</sub> from treatment facilities, transportation, storing and bury it to the bottom of the ocean.

Remember that, we save hundreds of high pressing compressors, because we just have a high pressing compressor only as device of technology process. On the other hand we exclude high-pressing metal bottles to contain liquid CO<sub>2</sub> as the intermediate stage of storage, now no longer needed. Eliminates the pumping process of liquid CO<sub>2</sub> through high pressure pipeline.



**Drawing 26:** The process of CO<sub>2</sub> separation, storage and transportation in the form of moisture NaHCO<sub>3</sub>, buried it in the form of clean liquid CO<sub>2</sub>

## Second Solution: Separation, Storage, Transportation and Burial CO<sub>2</sub> on the Ocean BOTTOM Undre form of Dry Ice

If storing CO<sub>2</sub> in the geological area was once a tank of oil, after oil extraction, we will meet with the following constraints:

1. The extraction wells were not many, so it is very expensive if the place to exploit oil wells far from the collect CO<sub>2</sub> place.
2. Must contain liquid CO<sub>2</sub> in high pressure metal bottles.
3. After storage, we cannot collect again, if we want to.

We propose second solution, in which CO<sub>2</sub> separation, storage, transportation and burial in the form of dry ice.

Second option is implemented in the following stages

### Stage 1: Preparation of dry ice CO<sub>2</sub> storage warehouse in the ocean floor

We choose a particular location on the surface of the ocean, with depths of about 2,000 meters above sea level, to construct suitable warehouse for dry ice CO<sub>2</sub> storage, how, ocean currents and moving sea flow, does not affect the long-term survival of this repository, and if necessary we can move these containers, even if we can recover the CO<sub>2</sub>, if necessary.

### Stage 2: Prepare packaging for dry ice CO<sub>2</sub>

Dry ice is normally stored in wooden boxes in normal climatic conditions. From dry ice is often a small amount of CO<sub>2</sub> released. Thus, the packaging containing dry ice must be the right thickness for preservation and transportation, and on each barrel must have a one way valve for CO<sub>2</sub> from dry ice container out, the water does not seep into the dry ice container. In short, this is an important product, it must meet all of the requirements necessary for long-term storage of CO<sub>2</sub> under the ocean floor.

### Stage 3: Production of dry ice

Initially we proceed collect CO<sub>2</sub> from industrial emissions processes in the form of cleaning liquid CO<sub>2</sub>, and the problem remainder is produced dry ice from cleaning liquid CO<sub>2</sub> [31]. This production is quite common. Dry ice must have proper shape to store in the appropriate packaging.

### Stage 4: Transporting dry ice

Dry ice is added to the required packaging, and we transported they to the barge, each time can be millions of tons, and the barge will be transported to the required location at sea, to storage of CO<sub>2</sub>.

### Stage 5: storing CO<sub>2</sub> to the ocean floor

The dry ice containers are continuously transported from the barge into the open sea, they were joined together, and in a form of drop-down continuous line to warehouse, to store them on the ocean floor. These wires are used to connect these dry ice containers, are needed to transport CO<sub>2</sub> to another, if necessary, or to recover CO<sub>2</sub> to serve a different purpose to it. Initially CO<sub>2</sub> is in the form of dry ice, dry ice will vaporize with the time, and under pressure near 200Atm, CO<sub>2</sub> gas into liquid CO<sub>2</sub>, meaning that in the long run, the container contain dry ice becomes containers with the liquid CO<sub>2</sub>.

Because the ocean depths over 2000 meters, the storage of CO<sub>2</sub> should be monitored and checked, so we need to have the appropriate technical means for the storage of these.

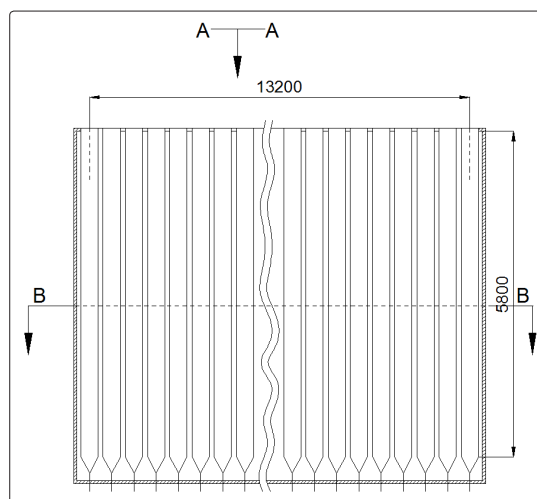
The theoretical calculations initially, let us hope, for the entire cost

of CO<sub>2</sub> collected, preserved it, transporting it, and the final storage of it to the bottom of the ocean can be reduced to more ten times compared with the cost of this notice, ie about 4-7 USD / ton CO<sub>2</sub>.

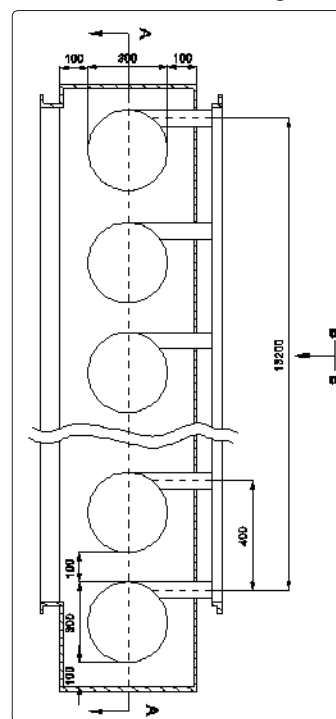
## Design of the Main Industrial Machines with Large Enough Power, Suitable for the 3,4 Million M<sup>3</sup>/H. Emission Treatment Technologies from 1000mw Thermal Power Plant.

### The combined upgraded wet or dry cyclone dust separator

Combined dry or wet upgraded Dust separator must has the capacity Large enough to treat the 3.4 million m<sup>3</sup> / hour industrial exhaust gas from the 1000MW fossil fuel power plant is shown in Figures 27 and 28 below [8].



**Drawing 27:** Combined dry or wet upgraded dust separator has the capacity large enough to treat the 3.4 million m<sup>3</sup> / hour industrial exhaust gas from the 1000MW fossil fuel power plant [8].



**Drawing 28:** Cross section (B-B) of drawing 4 Rotary KILN for Thermal Decomposition of NaHCO<sub>3</sub> in Liquid Phase

We performed a pilot study to separate 15 % VL.CO<sub>2</sub> from the gas mixture with a capacity of 0.3 m<sup>3</sup>/hr., % CO<sub>2</sub> conversion of is 94 %, use 20 % WP soda solution line , velocity is 0.9 kg / hr . So to handle 3.4 million m<sup>3</sup>/hr. the entire emissions of 1000MW thermal power plant will require [31]:

$$0.9\text{kg/hr} \times 3400000\text{m}^3/\text{hr.} / 0.3\text{m}^3/\text{hr.} = 10200 \text{ T/hr soda solution}$$

Density of solution of almost 1, so we take the density is 1, so we have line 10.200 m<sup>3</sup>/hr soda solution. If L is the volume for soda solution, W is the velocity soda solution (10 200m<sup>3</sup>/hr.), and T (20minut) is the retention time of the soda solution; volume of the rotary kiln is calculated as follows:

$$L = W \times T = 10200 \text{ m}^3/\text{hr} \times 1/3 \text{ hours} = 30\ 600 \text{ m}^3$$

We take T equal to 20 minutes for the process of thermal decomposition occurs perfectly.

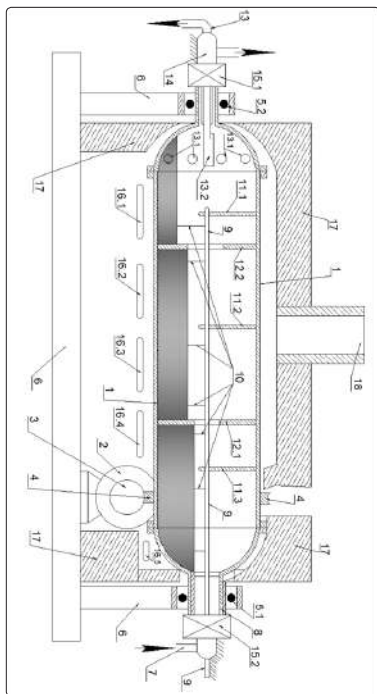
We believe the hollow in rotary kiln accounted for 60 % volume of the rotary kiln, so the actual volume of the furnace will be:

$$30600 \text{ m}^3 \times 100/40 = 76500 \text{ m}^3$$

We can choose the 10 rotary kilns operating in parallel. So each furnace can 7650m<sup>3</sup>. We calculate the parameters of the furnace (can see drawing 29)

Diameter of the rotary kiln: **8 meter**

Length of the rotary kiln: **152 meter**



**Drawing 29:** Rotary kiln for the thermal decomposition of NaHCO<sub>3</sub> in the solution

### Combined GLSHR

#### Background

Normally when applying the results of the pilot study laboratory, to develop large-scale industry, One has to follow the rules of advanced nonlinear experiments that are difficult to implement and also costly,

as the average productivity of a unit of cross section decreases when the cross section of the device increases.

On different points of cross section of the SLGHR, the linear stirring speed is completely different, the points near the stirring shaft have a stirring velocity near zero, while the points at the end of the stiring paddle have a linearly stirring velocity reaches maxima.

In our case for the combined GLSHR is quite different. We fix the flat stirring paddles, most of the cross sections of the combined SLGHR are agitated twice in opposite directions with almost the same total of straight stirring speeds. This creates a very important effect. The resulting effect of stirring is almost the same for the whole cross section of the combined SLGHR, and thus the capacity of the machine will be almost linear rate with its cross section, so the productivity of the combined GLSHR will be linearly proportional to the number of single GLSHRs, in other words for the combined GLSHR its productivity will be linearly proportional to the cross section of combined GLSHR. This is an important scientific basis for us to undertake the design of the combined GLSHR.

#### The Cross Section Calculation of the Combined GLSHR

If W is a capacity of emissions of thermal power plants ( 3.4 million m<sup>3</sup> / hr.), S is the cross section of the combined GLSHR (m<sup>2</sup>), V is the straight velocity of the gas stream moving through the combined GLSHR , we with the following formula:

$$W = S \times V$$

We choose V of 0.1 m / sec, we calculate the S

$$S = 3,400,000 \text{ m}^3/\text{hr} / 0.1 \text{ m/s} \times 3600 = 9444 \text{ m}^2$$

#### Height Calculation of the Liquid Layer in the GLSHR

As the height of the fluid layer in the device , from the experimental results , we know retention time Q is 40 seconds , so the fluid amount L is contained in the device, W is a capacity of emissions of thermal power plants (3.4 million m<sup>3</sup> / hr):

$$L = Q \times W = 40 \text{ s} \cdot 3.400.000/3600 \text{ m}^3 / \text{s} = 37\ 777 \text{ m}^3$$

I rounded the 38.000m<sup>3</sup>. While it was known that the sectional area of 9444 m<sup>2</sup> is GLSHR, so liquid layer height h is:

$$38.000 \text{ m}^3 / 9444\text{m}^2 = h = 4.0 \text{ m}$$

#### Quantity Calculation of Combined Single GLSHR Layout on a Layer

We chose the combination GLSHR on the equilateral triangle principle. Thus each single GLSHR be made in 1 equilateral triangle. Cross section area of the device is determined by the total area of all the equilateral triangles, it is the number of all single GLSHRs, and the total area of the all small parts surrounded cross section of combined GLSHR.

We chose single GLSHR diameter of 5 meters. So the area of an inscribed equilateral triangle of a single GLSHR is S<sub>1</sub>, and S<sub>2</sub> area of small part.

$$S_1 = 8.12 \text{ m}^2$$

$$S_2 = 3.835 \text{ m}^2$$

The number of all single GLSHRs about: 9444m<sup>2</sup> / 8.12 m<sup>2</sup> = 1163 so, if we arrange the all single GLSHRs on 3 floors, so on the 1 floor will be about 1163/3 -> 387 single GLSHR. Because in the cross section of the combined GLSHR is the area of the triangle (S<sub>1</sub>) and

the area of the small parts (S2)F , so the number must be less than the 1163. After determined we know 354 single GLSHR arranged on a floor. Including 3 floors will be 1062 single GLSHR [42].

The area of the 1 floor section is calculated as follows:

- 1- Area of 354 equilateral triangle is :  $354 \times 8.12 \text{ m}^2 = 2874.44 \text{ m}^2$
- 2- Area of 68 small part :  $70 \times 3.837 \text{ m}^2 = 268.59 \text{ m}^2$ .

**Total cross section of a floor: 3143.03 m<sup>2</sup>**

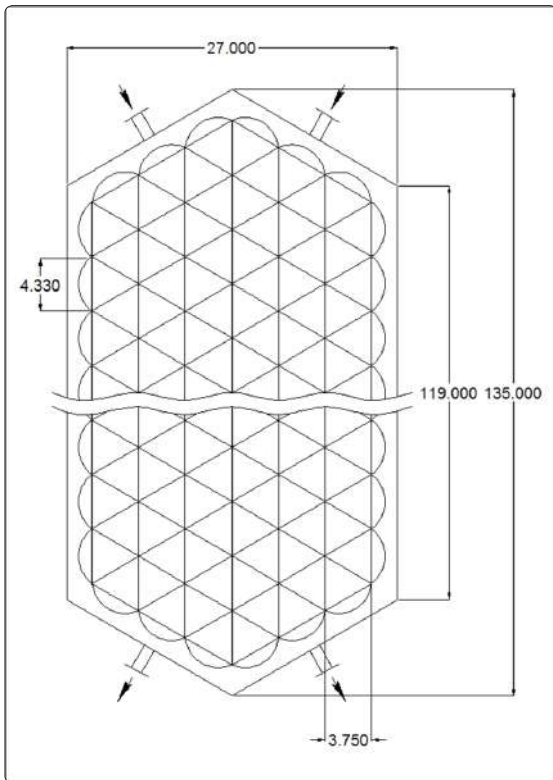
The layout design of the whole unit on a floor GLSHR is presented through drawing 30.

**Combined GLSHR Afford Handling Flow Gases 3.4 Million M<sup>3</sup> / hr. From 1000mw Thermal Power Plant using Coal as Fuel**

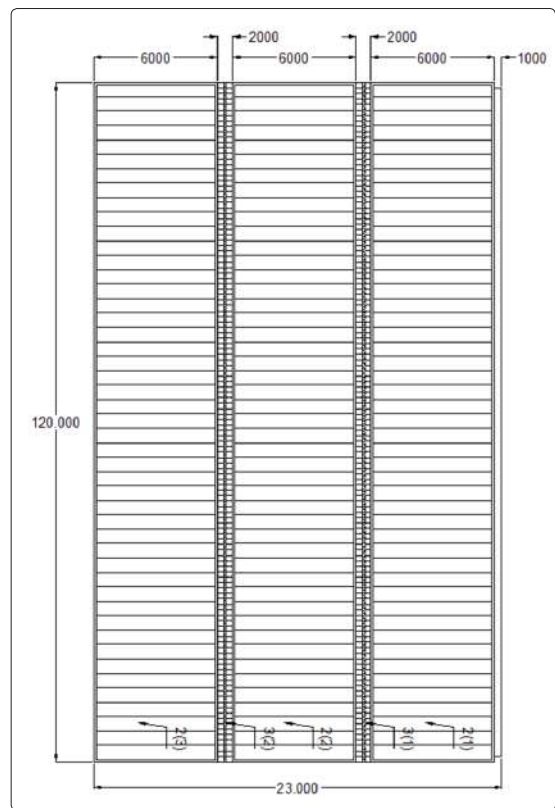
So to get a combined GLSHR afford treatment of industrial waste gas stream 3.4 million m<sup>3</sup> / h, we have arranged the GLSHR on 3 floors , each floor has 354 single GLSHRs , all 3 floors will have 1062 single GLSHR figure 31 shows this arrangement:

**The total cross section of combined GLSHR: 3135.26 m<sup>2</sup> x 3 = 9405.78 m<sup>2</sup>**

- The overall height of..... 23 m
- Horizontally..... 135 m
- Width (section of Combined 354 SLGHR ) ..... 27 m (see figure 30)
- Surface of combined machine ( 135 x 27 ) = 3645 m<sup>2</sup>



**DRAWING 30:** Layout 354 combination GSLHR on a floor



**DRAWING 31:** Arrange all 3 floors of combination GSLHR, with appropriate capacity to handle 3.4 million m<sup>3</sup> / h emissions of 1000MW thermal power plant

**Conclusions of the Project**

**Conclusion on the Generation of the Suitable New Equipment**  
 If we want to solve large and difficult problems as to handle industrial-scale emissions of millions of m<sup>3</sup> per hour, we need a generation of the suitable new equipment. If we do not find new devices such as 9 new dust separators, 4 gas liquid solid heterogeneous reactors, continuous filtration decant flocculation tank, make sure that we cannot resolve completely the issues.

**Conclusion on the Suitable New Technologies**

There are new devices, not entirely solve the problem, the more important is to find the new technologies. There are need be the new no-waste technologies. As this, a high economic efficiency as possible, environmental protection issues solved thoroughly. Thanks to the new no-waste technologies are applied, we absolutely can handle industrial emissions with any large scale. We absolutely can overcome greenhouse effect.

**Conclusion on the Two Stages for the Treatment of Industrial Exhaust Gas**

We believe that treatment of industrial exhaust gas to go through the following two stages:  
 Stage 1- Treatment to thoroughly the dust and toxic acid oxides contain in the industrial emissions, because, Industrial dust and toxic chemicals have killed millions people each year. Thus from any basis for any production, big or small, exhaust gas lines must be treated dust and toxic acid oxides , prior to discharge into the human living environment.  
 Stage 2 - CO<sub>2</sub> separation of from industrial emissions.



## Conclusion on the CO<sub>2</sub> Separation from the Industrial Emissions, Transportation and Storage of CO<sub>2</sub>

Based on a new technology proposed by us, the CO<sub>2</sub> separation from industrial emissions, as well as storage and transportation of it can be under the form of powder NaHCO<sub>3</sub>.

## Conclusion on the CO<sub>2</sub> Storing on the Deep Ocean

SOLUTION 1: Storing CO<sub>2</sub> in the form of clean liquid.

SOLUTION 2: Storing CO<sub>2</sub> in the form of dry ice.

## Conclusion of Economic Efficiency

The project will be implemented through a variety of levels, ranging from small to large and so, economic performance will be expressed differently. In the first stage, the product is not large, but very valuable, because it is food clean liquid CO<sub>2</sub> or dry ice. If we provide these products to the food industry, we get very high profits. Then, when we have enough supply for the market, we can begin to bury CO<sub>2</sub> on the ocean floor:

- if CO<sub>2</sub> will be buried in the form of clean liquid CO<sub>2</sub> at a cost about ten times smaller the current cost (theoretically).
- if CO<sub>2</sub> storage in the form of dry ice, the cost will be very small compared to current costs of bury in the form of clean liquid CO<sub>2</sub>.

## General Conclusion

Summing up, we can recognize that, we absolutely can handle industrial emissions for any scale, especially industrial waste gases emitted from thermal power plants using fossil fuels, so, greenhouse effect as will be resolved, by new no-waste technologies. Make sure that the living environment for humans will be protected, on the other hand, if we come to a decision, it is imperative to thoroughly handle dust and toxic acid oxides of all industrial waste gas stream, to ensure habitat for humans. So, we can co-solve the two problems are equally important:

A- Environmental Protection of human life.

B- To overcome the greenhouse effect to anti global climate change.

The success of this project, allows us to think about productions by no-waste technologies, as well as the no-chimney industries in the near future.

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