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ENGINEER'S STRATEGY FOR AIR POLLUTION CONTROL

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Abstract. *Air pollution control models, based on engineering techniques, are represented in the paper. The main goal of these models is air pollution reduction or elimination from the anthropogenic sources. Generally, the models refer to the overall existing technologies or operation in them, change of used fuels, and the control equipment use between the source point and the point of emission in atmosphere. The acceptable solution is the transformation of the insulated pollution into less harmful one with the possibilities of using the new material.*

Key Words: *Air Pollution Control, Engineering*

Appliance of control technology in order to evaluate air pollution implies reduction of the source emission below the standard limits. Control technology cannot be applied to the pollution source that is impossible to supervise, like, for example, a volcano. Also, it is unrealistic to hope that we can reduce the pollutant emission to zero only by using control measures. Costs of control measures for some pollution source usually represent an exponential function of the applied control in percentage. Involving of economic factor in the installation process of control technology emphasizes the importance of the required control level. The typical costs curve for the control equipment installation is shown in Fig. 1.

If there is some economy evaluation of recycled (refreshed, newly attained) material, the figure is quite different. Fig. 2 shows preliminary control costs with curve which represents achieved benefit. Factory management will demand the named curve which will be operative in the area left of two lines intersection. Also, the intensity of the local air pollution source will demand an area on the right side of Fig. 2, as much it is permissible by the best available control technology.

Control of any pollution source demands complete understanding of pollution and the source. There are requests for engineers to understand all physical and chemical components emitted from the source. They have to know the agency rules and regulations which are dealing with air pollution control, as well as the agency which is competent for construction, performing and final evacuation of the waste.

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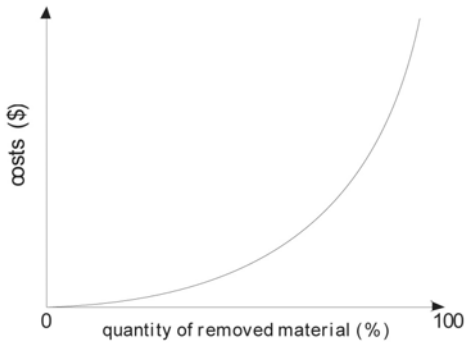

Fig. 1 Costs of Air Pollution Control Equipment

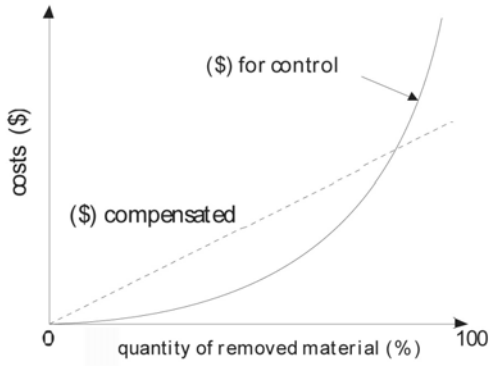

Fig. 2 Costs of Air Pollution Control Equipment with Required Value

Often, it is necessary to heat or cool gaseous pollutant before the control system. Engineer has to understand characteristic of the gaseous pollutant, thermodynamic attributes and possible reaction in order to achieve the desired activity. For example, if the gas is being cooled, there can occur condensation if the temperature is below the dew point. Further, injection of atomized water in hot gas, in order to cool it, can change the specific heat of the mixture. Also, if there is a gas moving through pipes, ducts and ventilators and control equipment, for example, there will be temperature and pressure changes, velocity and some specific quantity.

Atmospheric emission control from the process generally has one of three profiles depending on the kind of process, fuel, kind of applied equipment and so on.

The three methods are:

1. Changing of process to less destructive or reducing the emission from existing process through its modification or changing of operation.
2. Changing the fuel to achieve the desired level of emission.
3. Installation of the control equipment between source of the emission and its exhaust in the atmosphere. The control can be based on the pollution elimination or its transformation into a less destructive form.

1. CHANGING THE PROCESS

Changing the process is related to the operation mode change (functioning algorithm) or transition to quite a new process. There is a new recently adopted term: prevention of the pollution.

Let's assume the situation in which the state legislature adopts a new regulation related to the existing contaminant, and which demands drastic reduction of atmospheric emission. The task for company management is to solve this newly-emerging situation.

The management has few options for decision:

– To use a more expensive solvent with lower vapor pressure, which emits less organic compound.
– To reduce solvent temperature and moderate transition in order to achieve efficiency of purification.

– To install purifier, ventilation pipe or recirculation system in order to reduce atmospheric pollution and to economically use the solvent.
– To install purifier, ventilation pipe or combustion system with smaller pollutant emission.

In some cases the cheaper control assumes the old one being replaced with quite a new process with smaller pollutant emission. Moreover, the increase of the production and material recycling can be in cost balance. Likewise, it is equally beneficent to abandon old steel works and replace them with completely new ones. Often, there are not many expensive pollution control methods in the factories based on the replacement of the old furnace with high emission, with quite new one with a different design. Additional capacity for production increase lies in the balance of partial costs for introduction of a new type of furnace.

2. CHANGING THE FUEL

In many situations related to the air pollution control in the past, the ideal solution was to replace the fuel with smaller pollutant emission. For example, the power plant emitting a huge quantity of flying ash and SO_2, could be replaced with the fuel with natural gas which was a more economic solution than the installation of control equipment. Moreover, the current problem is strong concurrent ion for fuel with a small level of pollution, because of the natural gas default.

In the past, the practice was not to change the fuel in order to reduce pollution until the pollutant quantity reaches the critical upper limit. The government agency for air pollution control allowed power plant to use oil as fuel in a given period of time in a year when the pollutant quantity in the air is below the lower limit. The practice in the past years shows that the common fuel replacement with a low emission one represents a rational solution. The importance of this solution is even greater in view of the energy costs nowadays.

Some characteristic observations are:

1. Which are the current and future prospective fuel sources? Natural gas reserves are in deficit in many regions. Moreover, it is impossible to make conversion in large companies involving their location, infrastructure, and capacity on the new energy sources.
2. Large steam boilers using fuels which are separated in sections. An actual example is steam boiler which is using wood as primary fuel and oil as secondary fuel. This concept of using different type of fuels depending on current air quality helps to reduce practical emission and also to achieve minor cost reduction. The factories are enforced to use oil in cold period because of natural gas deficit. Then, increased emission (particles, smoke, fume) strongly exceeds emission using wood as fuel.
3. Register of low sulfur fuel suppliers cannot be entirely useful. The reason is based on fact that large percent of low sulfur coal is owned by steel works companies. Therefore, such coal is not available for use in power plants.
4. There is significant competition of fuel exploitation with low pollution product. Because of more requirements for such kind of fuels, a considerable fuel deficit

can happen in the wintertime in some large cities. For example, during the period of extensive low sulfur fuel consumption, its reserves are significantly consumed. Moreover, one of the prospective solutions is to use alternative fuels in power plants. For example, steam boilers can consume wood as primary fuel, and oil as alternative, or natural gas as primary and oil as secondary fuel.

The increasing use of the nuclear power plants, nowadays, for the production of electric power is also a very important issue. Although the nuclear power plants represent an effective solution, there are a number of ecological proceedings to consider. On the other hand, the research studies show that the nuclear power plant is much less contaminating in its regular operation than the power plant using fossil fuels. Moreover, the problem is becomes even bigger when it comes to the problem of nuclear waste disposal; in addition, there are other basic advantages and disadvantages.

3. USE OF CONTROL EQUIPMENT FOR PURIFICATION

It often happens that the sufficient control cannot be achieved by changing of fuel or process only. In such cases, it is necessary to reduce the pollution level to the acceptable one, before the emission in atmosphere.

The necessary equipment consists of purifier, pipelines, ventilator, disposal and recycling systems. The system should be planned to achieve maximum efficiency. Because of the incompatibility of components, many systems are operating with efficiency lower than the maximal.

The control equipment efficiency is specified before its purchasing. Determination of purifying efficiency is presented by equations (1) and (2):

$$\text{Efficiency, \%} = 100\left(\frac{C}{A}\right), \text{ and since } A = B + C \tag{1}$$

$$\text{Efficiency, \%} = 100\left(\frac{C}{B+C}\right), \text{ or } 100\left(\frac{A-B}{A}\right) \quad \text{or } 100\left(\frac{A-B}{B+C}\right) \tag{2}$$

where:
A – quantity of pollutant on entrance, before purifier
B – quantity of pollutant kept in purifier
C – quantity of pollutant on the way out, after purifier

The acceptable final test is based on appropriate measure and equations. For a completely correct efficiency test, the test itself has to include arresting and decreasing in calculation.

The removal of pollution from the bearing gas stream is possible because of different nature of these two systems. Pollutions might be with various dimension, inertia, electric characteristic, or adsorption feature. The required pollution disposal efficiency of the designed equipment based on scientific principles is essential for pollution parting mechanism from bearing gas.

4. Storage of Disposed Pollutant

Disposal of removed materials (pollutants) is a very important activity. They can be disposed on the appropriate dump area if the collected material is rare. If we are dealing with toxic waste, there are strongly recommended rules dictated by the legal regulations.

A life-dangerous waste can be divided in some categories which represent its potential or current activity.

The most common categorization is:

1. Toxic substance (acute or chronic damage concerned with living systems)
2. Flammable
3. Explosive or highly reactive
4. Provocative, meaning provoking some kind of irritation or hypersensitivity
5. Corrosive (strong oxidatior)
6. Radioactive
7. Cumulative (with toxic activity)
8. Genetic interactive (carcinogenic) which can be aligned in more than enumerated categories; moreover, they can be recognized as life dangerous.

Preventive measures involve condensation (dehydration) or dilution if we are talking about liquid or mud. This kind of activity is not only effective for waste reduction, but it also helps to easier organization and transport activity.

The main goal of life hazard waste disposal is the prevention of pollution in sensitive environment. Process such as surface water running off in neighboring water courses, underground water running off, atmospheric evaporation and biological accumulation, should be avoided in the period of active impact of life hazard waste. Moreover, the higher waste resistance to dissolution process causes an urgent activity for its isolation from the given environment. If the substance cannot be neutralized with some chemical treatment or incinerated (because of retain some hazards), one of the alternatives is to physically dispose of it to the place which is chemically safe.

5. Prevention of Pollution

Nowadays, the term "prevention of pollution" is widely adopted; it serves to describe technologies and strategies for reduction of pollution. In the technology-developed countries there exist special organized services promoting practical resources for the preservation of nature through the conserving and efficient usages of natural resources. The development of completely waste-free technology models is becoming more and more significant especially when it comes to the efficient selection of the pollution reduction mode.

All the countries which are using the modern technology observe the following guidance in order to share their common assumptions, namely:

- pollution should be prevented or reduced, whenever possible,
- pollution which cannot be prevented should be recycled in a safe way, whenever possible,
- removal or disposal of pollution in near environment should be practiced only as final solution with respect to the ecological, safe procedure.

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KONCEPTI INŽENJERSKE KONTROLE ZAGAĐIVANJA VAZDUHA

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U radu su izloženi modeli kontrole zagađivanja vazduha bazirani na primeni inženjerskih tehnika. Cilj primene ovih modela jeste smanjenje ili eliminisanje zagađenja vazduha iz izvora zagađenja antropogenog porekla. Modeli, ili koncepti, se generalno odnose na promene u postojećim tehnološkim procesima, u celiini ili do nivoa operacije, promenu korišćenih energenata i na kraju primenu kontrolne opreme (prečistača) između mesta nastajanja zagađenja i njegovog oslobađanja u atmosferu. Prihvatljivo rešenje je i transformacija zagađujuće materije u manje štetan oblik uz mogućnost korišćenja novonastalih materija.

Ključne reči: *kontrola zagađenja vazduha, inženjerstvo*