ELEKTROMAGNETIC HYDRO – GAZ CYCLONE FILTERS

R.A.Muradova

Azerbaijan State Oil Academy , Baku, Azerbaijan

ABSTRACT

There are a great number of different kind organic and natural admixtures in technological liquids and gases, which can drop production quality for the worse. That is why improved universal treatment devices (filters, separators) for these liquids and gases are in great need. From the other hand waste liquids and gases should be filtered before disposal because they damage environment. The importance of the environmental pollution control and treatment is undoubtedly the key factor in the human future.

Keywords: organic, filters, separators, magnetic, frequency

I. INTRODUCTION

Electromagnetic hydro (gas) cyclone is a combined apparatus for the technological and waste liquids and gases treatment by joint collinear influences of electric, magnetic and centrifugal forces. Similarly to traditional hydro cyclone, there are several different types of EMH construction [4,5]: cylindrical and conic EMH for two products, EMH for three products etc.

II. MAIN PART

First and especially second type of EMH are most useful ones and will be mainly discussed in this paper (Fig.1 and 2).EMH consists of cylindrical diamagnetic metal main body 1, conic or flat ferromagnetic metal inferior body 2, entrance 3 and output 4 nipple pipes, central light product pore out nipple pipe 5, flat ferromagnetic metal cover 6,bobbin around main body 7 and the pipes electrical isolations 8.

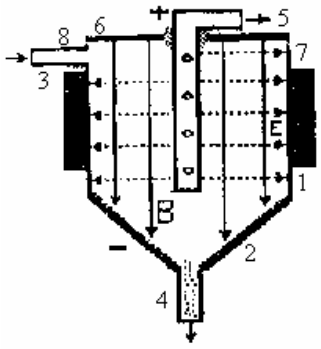

Fig.1

At it is illustrated in fig.1 and 2, an electric field force is produced by applied voltage between main body and central pour out nipple. Bobbin around main body produces a magnetic field force between flat ferromagnetic cover and magnetic conical bottom part of the EMH. There is inertial centrifugal force due to liquid (gas) high-speed rotation in cylindrical main body, because of the entrance nipple is tangential to the latter and high incoming flow velocity is equal to liquid (gas) rotation velocity. For some special cases ozone (O_3)can be produced around the central electrode to kill microbes, to fire poisonous natural or organic admixtures in outgoing pipe: high frequency extra voltage usually is applied throw a capacitor to this electrode.

Thus, in two words, technological or waist liquid (gas) enters throw input nozzle and heavy matter particles, such as sand, metals, silt, etc are displaced by centrifugal force to main body inner cylinder surface, then down and quit from conic exit. While light particles, such as oil and organic traces, gas babbles etc, are ousting to the central electrode-pipe and pour out of the EMH. In this system quality filtration rises very high due to electric and magnetic field application in addition and collinear to centrifugal force.

There are several forces that affect a particle in EMH in a common case :

$$F_m + F_e + F_S + F_i + F_a + F_w + F_c = 0 \quad (1)$$

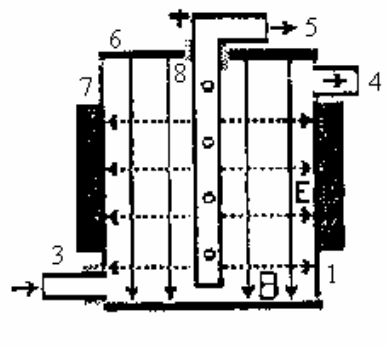

Fig.2

Where: F_m -magnetic forces, F_e -electric force, F_S -Stocks force, F_i - inertia force, F_a -Archimedes force , F_w -weight force, F_c - centrifugal force.

Comparative analyses [1] have shown that influences of F_a , F_i and F_w on a very small (less than 50 micron) dispersed particles are negligible and they can be omitted. The main influence belongs to active forces F_m , F_e , F_C and resistive force F_S .

The effect of centrifugal force on particle filtration is determined as:

$$F_C = \frac{\pi^* d^3 (\rho_1 - \rho_2)^* v_t^{\,2}}{6r} \qquad (2)$$

Where:

d -diameter of particles [m],

ρ_1 -density of technological liquids [kg/m^3],

ρ_2 -density of particles [kg/m^3],

r -average revolving radius [m],

v_t -velocity of particles [$m/\sec$].

In the case of $\rho_1, < \rho_2$ cleaned liquid exits trough the central pour out tube and mechanical particles are removed from bottom conical product pipe. In the case of $\rho_1 > \rho_2$ cleaned liquid is extracted trough bottom conical product tube and oil is removed from central pour out nipple pipe.

Generally, 70-80 % of particles in technologic liquids are charged by negative electric charge [1,2]. Electric and magnetic forces create an effect on the negative charged particles. They can be pushed or pulled to electrodes. Due to this fact central pour out tube is used as a positive electrode and cylindrical body as a negative one. There are some holes on this central tube for collecting light and charged particles such as oil, gas babbles, acetone, phenols, etc. The electric force effect on a charged particle can be find as:

$$F_e = E^* q \qquad (3)$$

Where: E - electric field strength (V/m),

q -average electric charge of a particle.

EMH radial electric field similar to electric field of cylindrical capacitor and E can be find as:

$$E = \frac{V}{r \ln \frac{R}{r_{CE}}} \qquad (4)$$

Where: R -diameter of outer electrode,

r_{CE} -diameter of central electrode-pipe,

r -diameter of any cross-selection.

Electric field reaches its maximum around the central electrode when $r = r_{CE}$ and its minimum around the outer electrode when $r = R$ .The average electric charge of a particle can be calculated as:

$$q = \frac{\varepsilon_0 \varepsilon S \xi}{\delta} \qquad \textit{Coulomb (C)} \qquad (5)$$

Where:

ε -relative permittivity $\varepsilon_m / \varepsilon_0 = 81$ $\varepsilon_0 = 8.86 \times 10^{-12}$ $Farad/m$

S -surface area of particle $d = 10\mu m$ $\pi d^2 = 3.14 * 10^{-10} m^2$

ξ -electro kinetic potentials $\xi = 0.1 - 0.5$ Volt

δ -doubled electric areas thickness $\delta = 10^{-6} m$

Thus, it can be obtained for different matter and $d = 10\mu m$

$q = (2-6) * 10^{-14} C$, for $d = 5\mu m$

$q = (0.5 - 1.5) * 10^{-14} C$ and for $d = 1\mu m$

$q = (0.125 - 0.375) * 10^{-14} C$

There are two main magnetic forces that suppose to be taken into account.

The firs one for magnetic particles only :

$$F_{qm} = H * q_m \qquad (6)$$

Where:

H -magnetic field strength (intensity),

q_m -magnetic charge of a particle.

II. CONCLUSIONS

The special construction of EMH was designed for filtration and separation processes of different liquids and gases, which have micro admixtures along with rather big particles. Similarly special constructions can be designed for many kinds of technological and waist Liquids and gases taking into account their demands and performance attributes. Some advantages of the EMH are the following:

1.It is a combined system designed to use the main

three forces altogether in the same direction.

2.There is no any active rotating mechanical part in EMH. Because of that this type EMH can be used in high- pressure technological systems without any risk.

3.Simple process control by means of electric and magnetic fields.

4.Available for many separation matters.

5.Possibility of ozone formation to burn poisonous organic admixtures and microorganisms.

REFERENCES

1. Ali-zadeh P.H., Kuliyev H.M., Guseynov E.N.
2. Electromagnetic cyclone separator-ozonizer, Patent №1-990127, Azerbaijan, 1999.
3. 2.Kuliyev H.M., Muradova R.A. Fully diagnostic determination of electric circuit parameter, Patent №I-20000200, 29.09.2000,Azerbaijan.
4. 3. Kuliyev H.M. Ecological matters of liquids and gases electromagnetical filtration in high-gradient magnetical field analysis. Journal " Bilgi " , Series "Techics ", Baku, 2000,p.29-34.
5. Ali-zadeh P.H.,Kuliyev H.M., Guseynov E.N.Electromagnetic hydro (gas) cyclone filters. The Int. Conf. "The Mankind and Calamities", Sept. 17-18, 2001, Baku, p. 98-104.
6. Muradova R.A. Researches of some methods of ferromagnetic particles deposit in dissimilar fields. Power Engineering Problems , № 2, 2003,p.104-106, Elm, Baku.
7. Muradova R.A. Mathematical model of electromagnetic filtration process of technological liquids and gases. News of Azerbaijan high technical educational institutions, № 2 (30) , 2004, p.66-68,Baku.