# Influence of Dust Re-Entrainment and Skew Gas-Flow Technology on ESP Efficiency

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## Influence of Dust Reentrainment and Skew Gas-Flow Technology on ESP Efficiency

by
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### 1. Introduction

The gas flow pattern is one of most factors influenced on ESP performance. From the White times [1] up to day the knowledge in this matter changed diametrically. The uniform gas flow occurs in the last decade not entirely good for ESP high performance. The properly formed "skew" flows become one of significance in ESP efficiency improvement [ 2-7].

The paper presents a computer analysis of the ESP efficiency whilst the gas flow and reentrainment has changed. It occurs the correlation between gas flow patterns and dust reentrainment.

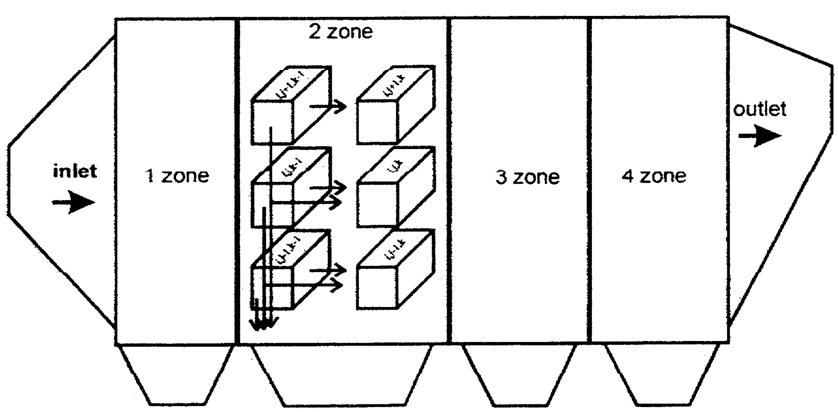
### 2. Model of phenomena

The four zones ESP have been analysed. To study the effect of gas flow distribution on ESP performance a discrete three- dimensional model of each treatment zone has been assumed ( see fig. 1). Each element of model performs according Deutsch - Anderson formula. In the earlier paper the operation of this model has been explained [5].

Analysed ESP has the following parameters:

- the length of electrically field L = 4 x 3.45m
- mean gas velocity v = 1.12 m/s
- electrode spacing s = 396 mm
- dust loading Sp = 22 g /m3
- migration velocity w = 0.087m/s

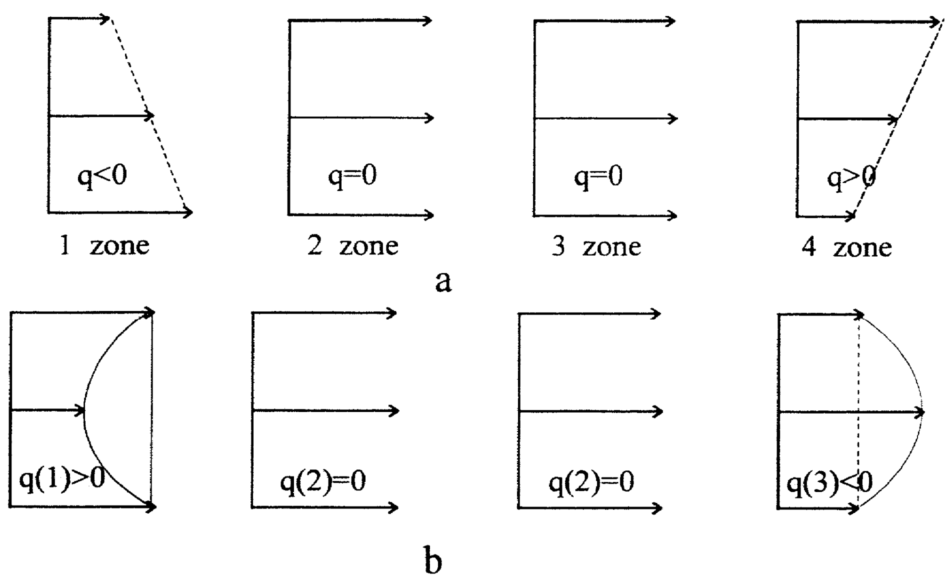
Fig 1. Model of calculation




### 3. Numerical analysis

The numerical analysis of ESP performance has been performed by computer programme SYMULA-X [5] . As a base for comparing analyses the uniform gas flow in each ESP zone is assumed. The two type of gas flow is analysed: linearly skew flows and concave-convex gas flow. The velocity profiles in vertical ESP cross section for linear skew gas flow is shown on Fig 2a. For estimation skews degree the index q is applied. It is for linear gas flow a difference between the gas velocity in top of profile and in the bottom value divided by 1 m/s.

Fig 2. The gas velocity profiles




On the Fig 2b are presented profiles of velocity while in the first zone the velocity is "concave" but on the outlet is "convex". For concave and convex gas flow pattern the index q is difference of gas velocity in the fringe and in the middle of the field divided by 1m/s.

## 4. Numerical results

The results of computer simulation are placed into figures 3 and 5.

On the fig 3 are presented the calculation of ESP efficiency while the gas flow is modified in first and fourth zone in complementary mode i.e. q(1) = - q(4) and q(2) = q(3) – see fig 2a. The reentrainment coefficient $\kappa$ ranges from 0.00 to 0.25. From this data follows that more convenient are gas flow patterns for which in first zone q(1)<0 then flow patterns for q(1)>0. The gradient efficiency is greater in the coefficient range q(1) = -0.9 to q(1) = 0.0 then in the range q(1) = 0.0 to q(1) = +0.9.

It is evident that the increase in efficiency is most significant for gas flows characterised by coefficients q(1) = -0.9; q(2) = 0; q(3) = 0; q(4) = + 0.9 to compare with uniform gas flow: q(1) = q(2) = q(3) = q(4) .

For reentrainment coefficients $\kappa = 0.00$, $\kappa = 0.08$ and $\kappa = 0.12$ the minimum efficiency falls for q(1) = 0, bat for $\kappa = 0.20$ and $\kappa = 0.25$ the minimum efficiency is shifted to q(1) = +0.50 – see fig 3.

On the fig 4 it is shown the interval of change in ESP efficiency corresponding two gas flow patterns: q(1) = - 0.9 and q(1) = 0.0 (data from fig 3). It follows that the decrease in efficiency resulting as increase in gas reentrainment may be compensated by appropriate skew gas flow pattern.

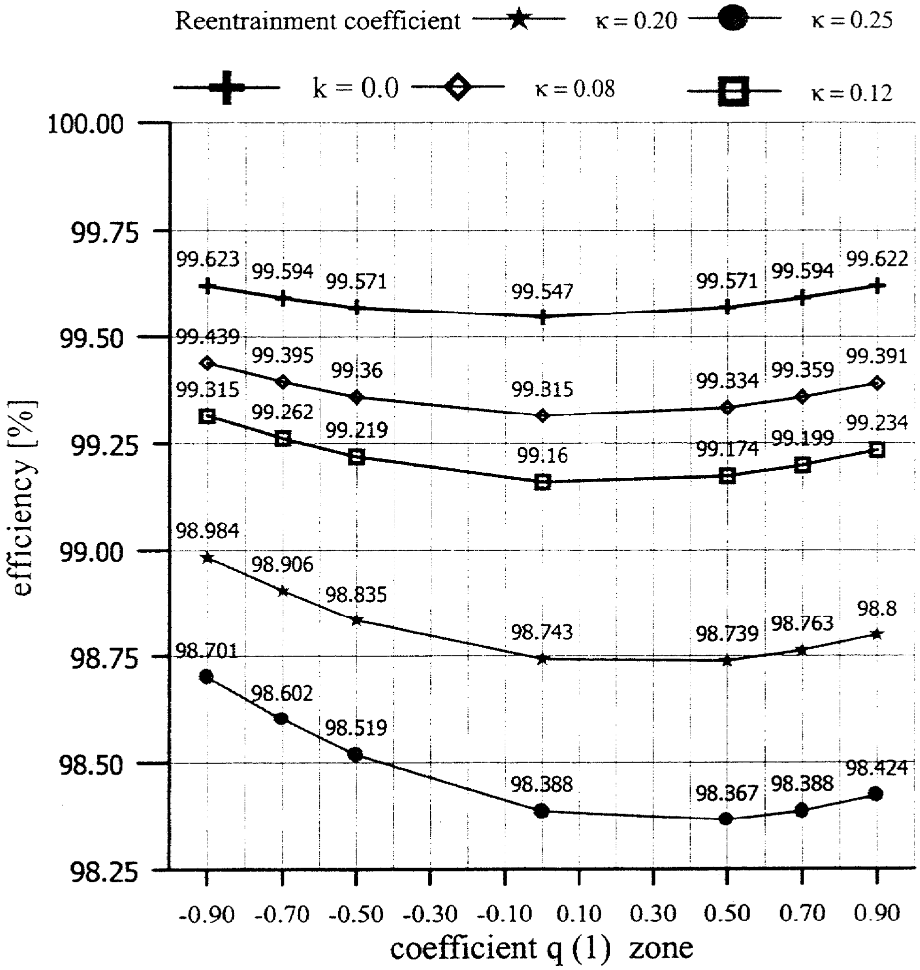



Fig 3. Efficiency versus skew linear gas flow

On the fig 5 has been presented computer simulation for concave gas flow in first zone and convex gas flow in fourth zone as in fig 2b. The results are similarly as for linear flows presented on fig 3. The increase in reentrainment coefficient accompanies increase in gradient efficiency while q(1) ranges from 0.0 to 0.9

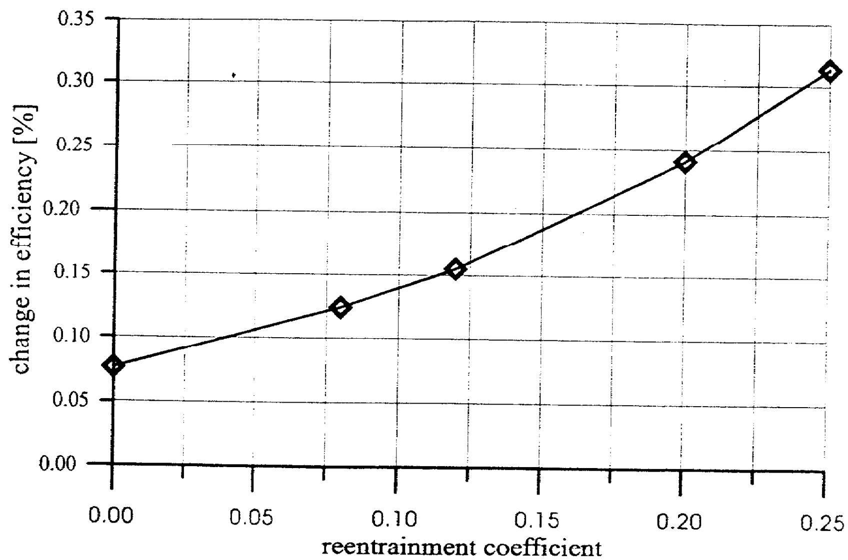



Fig 4. Change in efficiency versus reentrainment coefficient for case q(1) = -0.9; q(4) = +0.9

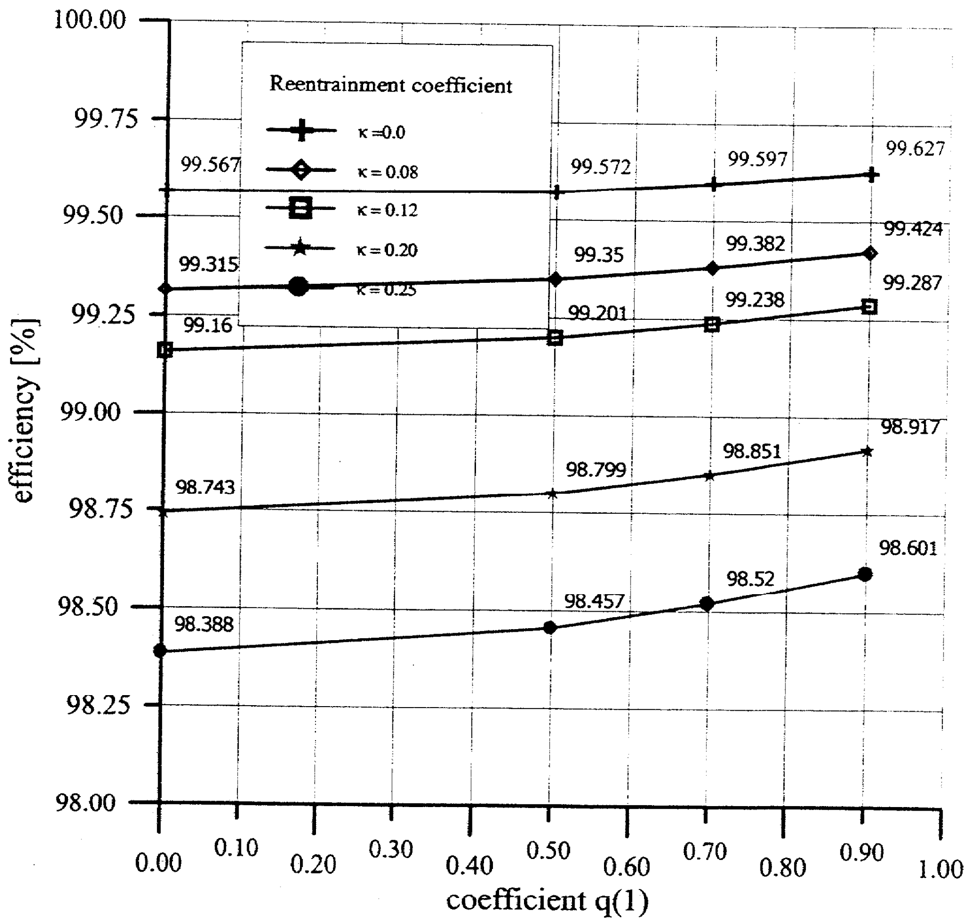



Fig 5. Efficiency versus concave and convex gas flow

## 5. Recapitulation

The linear skew gas flow and concave -convex configuration gas flow are attractive means for ESP performance improving. It is interesting that whilst reentrainment increases the skews effects is amplified . So the skew gas flow technology is worthy to be taken into consideration for ESP efficiency improving.

Literature:


1. White H.: Electrostatic precipitation, Addison Wesley. NY (1963), Reprint by IESP
2. Lind L.: Influence of gas flow distribution on precipitator performance, Six Joint EPA/EPRI Symposium on Transfer and Utilization of Particulant Control Technology, N. Orleans L.A. Feb. 1986
3. Hein A., Gibson D.: Electrostatic precipitator skewed gas flow technology- ESKOM experience in South Africa; 86th Annual Meting and Exhibition, Nashwille, Tennesse, June 23-28, 1986
4. Frank W.J.: Aspects of ESP upgrading, VI th Int. Conference on ESP, Budapest, Hungary, June 18-21,1986
5. Sarna M.: Some aspects of flow skew technology in ESP performance improvements, VII Int. Conference on ESP, Kyungu, Korea, 25 Sept. 1988
6. Jędrusik M., Sarna M.: Modeling of velocity field in electrostatic precipitator, VI Int. Conference of ESP Precipitation, Budapest, Hungary,18-21 June,1966
7. Sarna M.:Wpływ modyfikacji pola prędkości gazu na skuteczność elektrofiltru na przykładzie odpylacza zainstalowanego w El. Rybnik, Ochrona Powietrza i Problemy Odpadów, 5, 1999, pp 177-179 (in polish)