Analysis For Sampling Tube's Head of SCR DeNOx Reactor's Inlet Flue

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Abstract: The sampling tube is always used to collect flue gas in the field of CEMS,However， the inlet of SCR DeNOx reactor system always with more than 300℃， velocity comes to about 14m/s,as well as dust with high concentration.All these factors could reduce the life of sampling tube.In this paper,using software ANSYS to analyze the sampling tube.Resulting the dangerous areas,we could take some measures to extend the life of sampling tube.

1 Introduction

The SCR DeNOx reactor technology of Coal-fired power plants used for reducing the concentration of NOX in flue gas,as well as reducing environmental pollution.Under these reasons,related department require the Coal-fired power plants to set monitor system on the inlet and outlet of SCR DeNOx reactor flue.Inside of the flue especial inlet flue of SCR Denitartion exist such characteristics:high velocity,high temperature and high concentration of dust.The head of sampling tube is installed in flue directly,without any protective equipment.Hence,the head of sampling tube is easy to be damaged,replacing it is a trouble thing.In order to extending the life of it,in this paper,introducing how to get the "danger zones"by ANSYS Workbench software,in allusion to these "danger area",we can take some corresponding protective measures[1].

2 Influences caused by flue's inside flue gas

2.1structure of sampling tube's head

Making a small hole on the inlet flue of SCR DeNOx reactor,inserting the head of sampling tube in this hole,fixed by a flange.The front end of it is set to opposite the direction of smoke flowing.Deviation angle is 0°.Its structure is shown as figure 1.

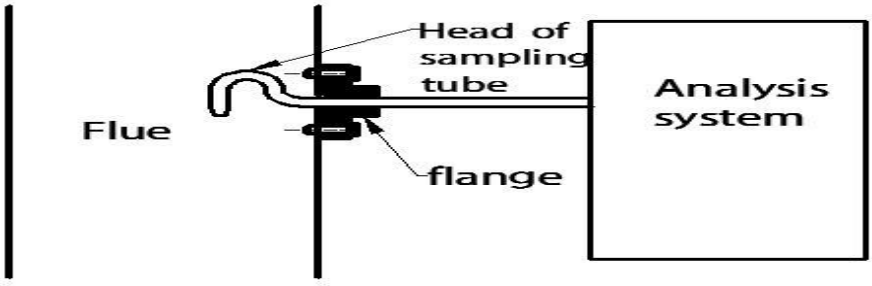

Figure 1 Flue gas sampling system

In figure 1,the flue gas produced by boiler enters into SCR DeNOx reactor system through the entrance of flue.Sampling tube must be installed in area with stable velocity,stable pressure and temperature.In this area,the concentration of dust is representative.Besides,the material of sampling tube is Q235 steel[2].

2.2 ANSYS Workbench Modeling Analysis

In order to getting "danger area"of sampling tube's head which produced by flue gas shocking it.Firstly,using Pro/E software modeling a sampling tube's head with 1:1 proportion.Next

step,importing the mold into Workbench,and begin CFX analysis.Setting the pressure of inside the flue as -0.8atm,velocity as 14.83m/s,density as 0.6kg/m3,temperature as 647K[3].Importing these parameters into CFX's setting module,simulating the flue environment.Resulting the pressure effects of Sampling tube's head caused by flue gas as shown in figure 2.

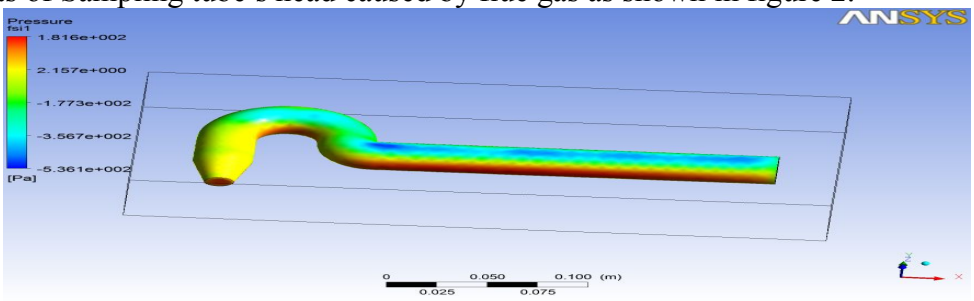

Figure 2 Pressure effects of sampling tube's head caused by flue gas

In figure 2,the area of maximum pressure is located on the surface which closes to flue entrance.Hence this area is defined as"danger area".The maximum pressure comes to 1.816x10^2pa,the minimum pressure comes to -5.361x10^2pa.

Not only analyzing the pressure of it,but also the equivalent stress is necessary.The equivalent stress of sampling tube's head as shown in figure 3[4].

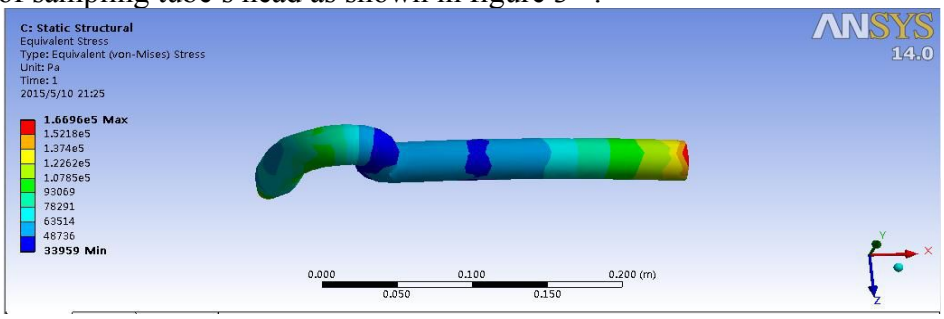

Figure 3 Equivalent stress of sampling tube's head caused by flue gas

In figure 3,the area of maximum equivalent stress located on the surface where sampling tube connecting with the flue wall,comes to 1.6696x10^5pa.We can defined this area as "danger area".The nearer from this area,the higher the equivalent stress is.The minimum equivalent stress located on the elbow of sampling tube's head,comes to 33959pa.

The total deformation of sampling tube's head is also necessary.We can find "danger area"in advance by analyzing total deformation,and can extended the life of sampling tube[5].The total deformation of sampling tube's head as shown in figure 4.

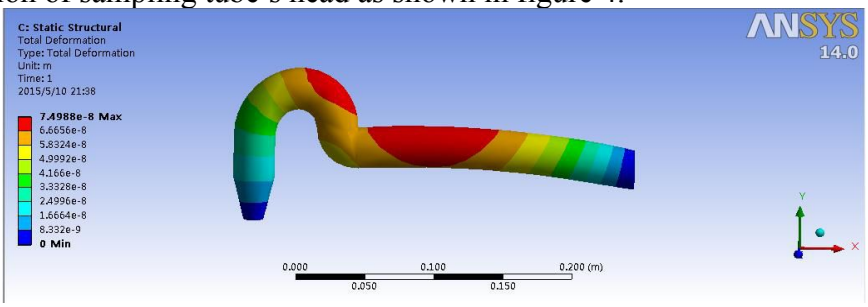

Figure 4 Total deformation of sampling tube's head caused by flue gas

In figure 4, the area of maximum total deformation located on the upper middle section of elbow of sampling tube' head,comes to 7.4988x10^-8m.This area is defined as"danger area".The minimum total deformation area located on the front of sampling tube's head and the surface where sampling tube connecting with the flue wall,comes to 8.332x10^-9m[6].In order to extending the life of sampling tube,we can take some protective measures on "danger area".

3 Influences caused by sampling tube's inside flue gas

Analyzing the stressing influences of sampling tube's head caused by flue's inside flue gas is important for extending life of sampling tube,as well as the influences of sampling tube's head

caused by sampling tube's inside flue gas. Because sampling tube's inside flue gas exist such characteristics:high velocity,high temperature and high concentration of dust.The sampling tube's head shocked by flue gas could reduce the life of sampling tube[7].

3.1 Pressure influences caused by sampling tube's inside flue gas

Because the flue's pressure is negative pressure,so installing getter pump in the other side of sampling system is necessary.The equilibrium velocity sampling tube is used for sampling flue gas usually,so the pressure of sampling tube's inlet is closed to the pressure of flue.We can set these parameters:inlet pressure is -0.8atm,velocity is14m/s,environment temperature is 647K.Importing the model into Workbench,analyzing the pressure influence caused by sampling tube's inside flue gas.Its velocity vector is shown as figure 5,wall pressure is shown as figure 6,velocity streamline is shown as figure 7.

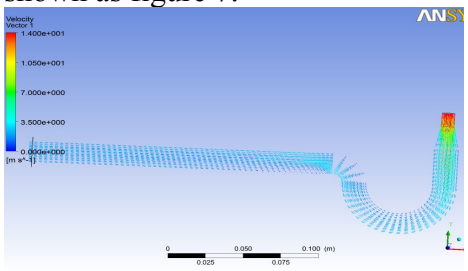

Figure 5 Velocity vector of sampling tube's inside flue gas

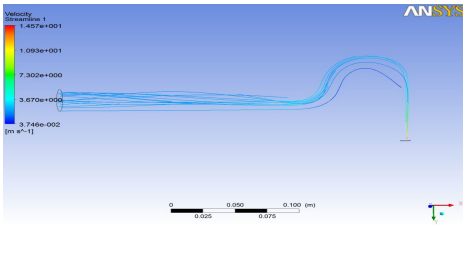

Figure 6 Wall pressure of sampling tube's inside flue gas

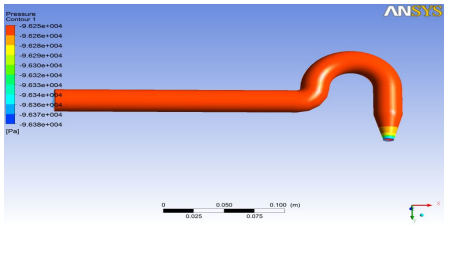

Figure 7 Velocity streamline of sampling tube's inside flue gas

In figure 5,the area of maximum velocity vector located on the front end of sampling tube's head,comes to 14m/s,equals to the setting parameter.Other areas is uniform roughly,comes to 3m/s.There is a slight increase on elbow,comes to about 5m/s.

In figure 6,the area of maximum wall pressure located on the most area of sampling tube except the front end,comes to about -0.925atm.The minimum area located the front end of sampling tube.The difference between minimum and maximum wall pressure is tiny.

In figure7,the velocity stream figure shows that flue gas in the front end of sampling tube is the most unstable.Other areas of sampling tube are stable relatively. The area of maximum velocity streamline comes to 14.57m/s,the minimum comes to3.67 m/s.

3.2 Influences of stress and strain caused by sampling tube's inside flue gas

Importing the model into static structural,setting the pressure of sampling tube.Equivalent stress of sampling tube's head is shown as figure 8[8].

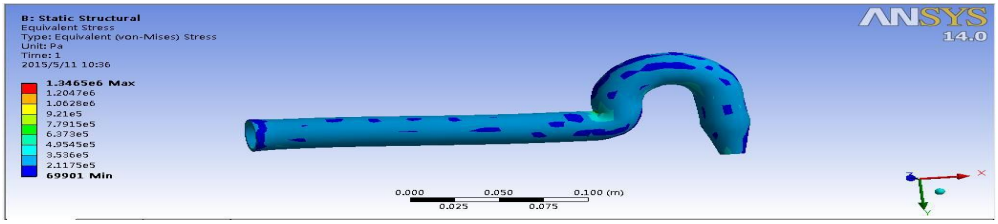

Figure 8 Equivalent stress caused by sampling tube's inside flue gas

In figure 8,the area of maximum equivalent stress located on where the elbow connecting with straight tube,comes to 1.3465x10^6pa. Other areas are uniform roughly,comes to2.11x10^5-3.536x10^5pa.So the "danger area"located on the area of maximum equivalent stress.

Total deformation of the sampling tube caused by sampling tube's inside flue gas is shown as figure 9.

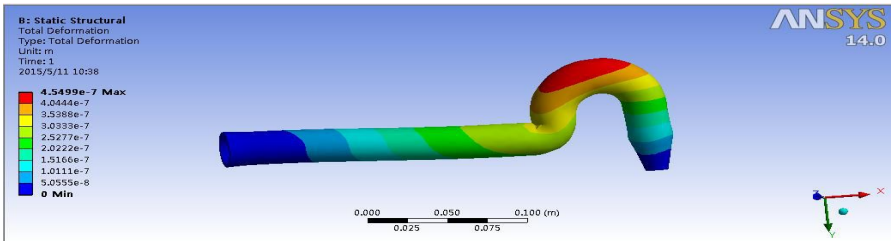

Figure 9 Total deformation caused by sampling tube's inside flue gas

In figure 9,the area of maximum total deformation located on the front end of elbow,comes to4.5499x10^-7m.This area is defined as "danger area".The area of minimum total deformation located on the front end of sampling tube and the area where the tube connecting with the flue,comes to 5.0555x10^-8m.

4 Conclusion

(1)Analyzing the stressing influence caused by flue's inside flue gas by using ANSYS Workbench software.Resulting "danger areas"of equivalent stress and "danger areas"of total deformation.
(2)Analyzing the fluid influence caused by sampling tube's inside flue gas by using ANSYS Workbench software.Resulting velocity, wall stress and streamline of sampling tube.
(3)Analyzing the stressing influence caused by sampling tube's inside flue gas by using ANSYS Workbench software.Resulting "danger areas" of equivalent stress and "danger areas"of total deformation.

Acknowledgment

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Reference

[1]Wang Wei,Numerical Simulation Research on the Field of the Entrance Flue of SCR DeNOx Reactor[D].Shandong University.2010 4.20.

[2]Zhang Linhan,A sampler Project on Air Combine with Particulate.[D].Wuhan Institute of Technology.2014.5.9.

[3]Chen Xingxing.Applying on Flue Gas of Sources of Pollution Sampling Method.[J]Science and Technology.2014.6.20.

[4]Chen Wei,Yang Donghua,Ma Li.Research on Sampling the Fumes at Fixed Pollution Sources.[J].Journal of Gansu Sciences.2011.6.15.

[5]Zhou Bihua,Zhao Fasheng.Discussing Instrumentation of SCR DeNOx reactor.[J].China Environmental Protection Industry.2015.2.10.

[6]Feng Zhengzhen.Research on the Method of Determining Flue Gas Velocity Measurement of Rectangular Gas Duct in Coal-fired Power Plant.[D].Nanjing University of Information Science&Technology.2011.6.1

[7]Yang Miaoxin,Hu Jianmin.PND_32 Fly ash Sampling Tube.[J]Thermal Power Generation1979.9.10.

[8]Xiao Hongwen.Exploring Technology of Flue Sampling.[J].Arid Environmental Monitoring.1992.4.1.