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Research Article

Simulation and Analysis on Horizontal Flow Separating Field of Urban Garbage

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Abstract: Prefect fore-separation technology is the key to realize garbage comprehensive treatment and increase resource utilization ratio. To the low purity quotient and efficiency of plastic and paper separation, through simulating and analyzing on velocity and pressure distribution of internal flow field for horizontal flow separator at different air-intake angle and wind velocity, reasonable processing parameter and better flow running condition are studied in this study.

Keywords: Air-intake angle and wind velocity, horizontal flow, plastic and paper separation, velocity and pressure distribution, simulation and analysis

INTRODUCTION

Facing to the serious position of rapid increasing amount and heavy pollution of urban garbage, reclamation, reducing quantity and hazard-free treatment of garbage treatment must be carried out (Guo *et al.*, 2005). At present, classified collection of urban garbage is not implemented in China and garbage has the characteristics of ingredient complex, high content of plastic, paper and water, serious ravelment. Prefect fore-separation technology is the precondition and key to realize garbage comprehensive treatment and increase resource utilization ratio. In the fore-separation process of garbage, the most difficult and the worst effective separation is plastic and paper. To them, the most effective method is flow separation. Its working principle is to separate plastic and paper from heavy ones by utilizing density difference of different garbage ingredients. According to special characteristic of different region and season's garbage, better separating purity quotient and efficiency can be obtained by adjusting processing parameter of flow separator, such as air-intake angle, wind velocity, length of out-feed channel (Lu *et al.*, 2005). Through simulating and analyzing on velocity and pressure distribution of internal flow field for horizontal flow separator at different air-intake angle and wind velocity, the influence of different intake angle and different wind velocity to internal flow field of horizontal flow separation ,reasonable span of processing parameter and better flow running condition are studied in this study. Technology reference and support is provided to equipment design and production of urban garbage treatment factory.

STRUCTURAL PARAMETER AND MODEL CREATION OF HORIZONTAL FLO SEPARATOR

Key performance index of horizontal flow separator is separation's purity quotient and efficiency of plastic and paper (Gao *et al.*, 2005). The main influencing factors are air-intake angle, wind velocity, drop height, length of separating system, length of heavy substance groove and light substance groove of horizontal flow separator (Li *et al.*, 2007). Therefore, main processing parameters of reasonable horizontal flow separator should be regulated in a given range. In order to obtain higher separation effect, those parameters should be adjusted correspondingly according to special characteristics of different region and season's garbage.

Length of separating system is 9000 mm, drop height is 2000 mm, length of heavy and light substance groove is 2000 mm and 1000 mm. Creation of geometric model and mesh division are finished in GAMBIT. Hexahedral mesh is adopted and map method is used to divide mesh. Spring urban garbage of North cities in China is used as analyzing object.

Plastic and paper moves along upper parabolic locus under the action of air flow's horizontal pushing force, vertical lifting force and self-weight. The smaller horizontal pushing force is, the shorter moving distance is. It is difficult for plastic and paper to reach to upper part of light substance groove, leads to worse separating effect. Lifting force can slow up the dropping velocity and increases separating time effectively. The bigger vertical pushing force is, the longer separating time is

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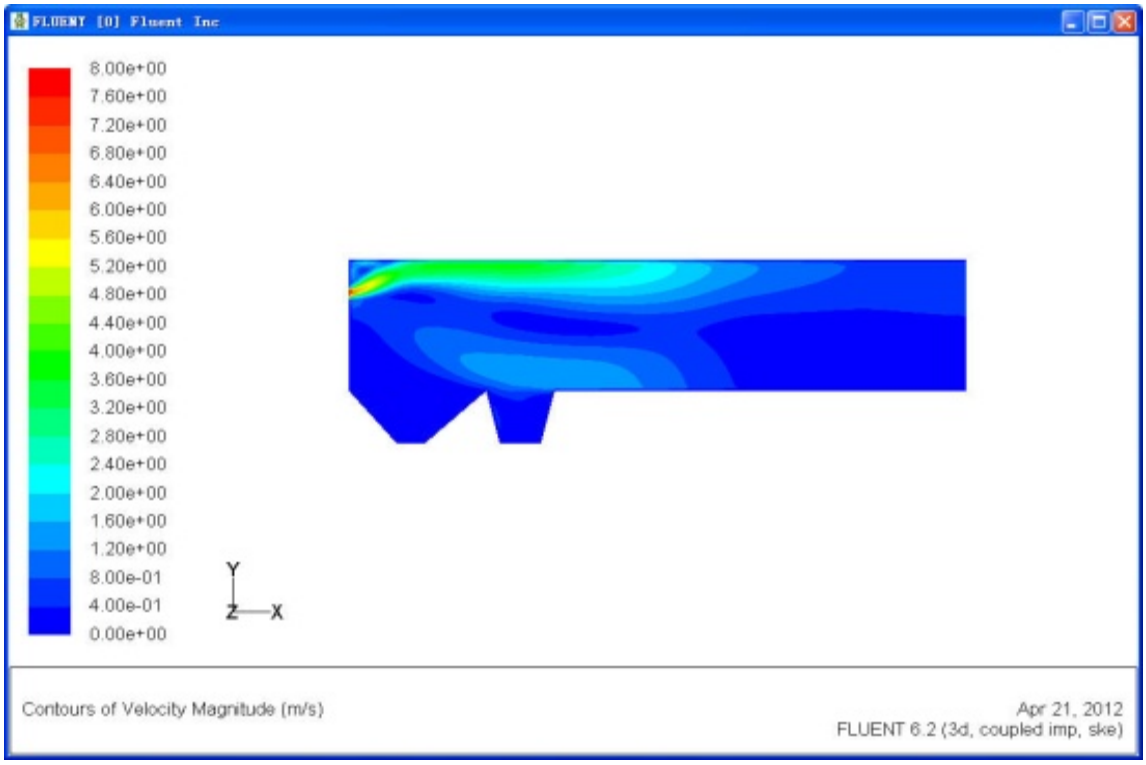
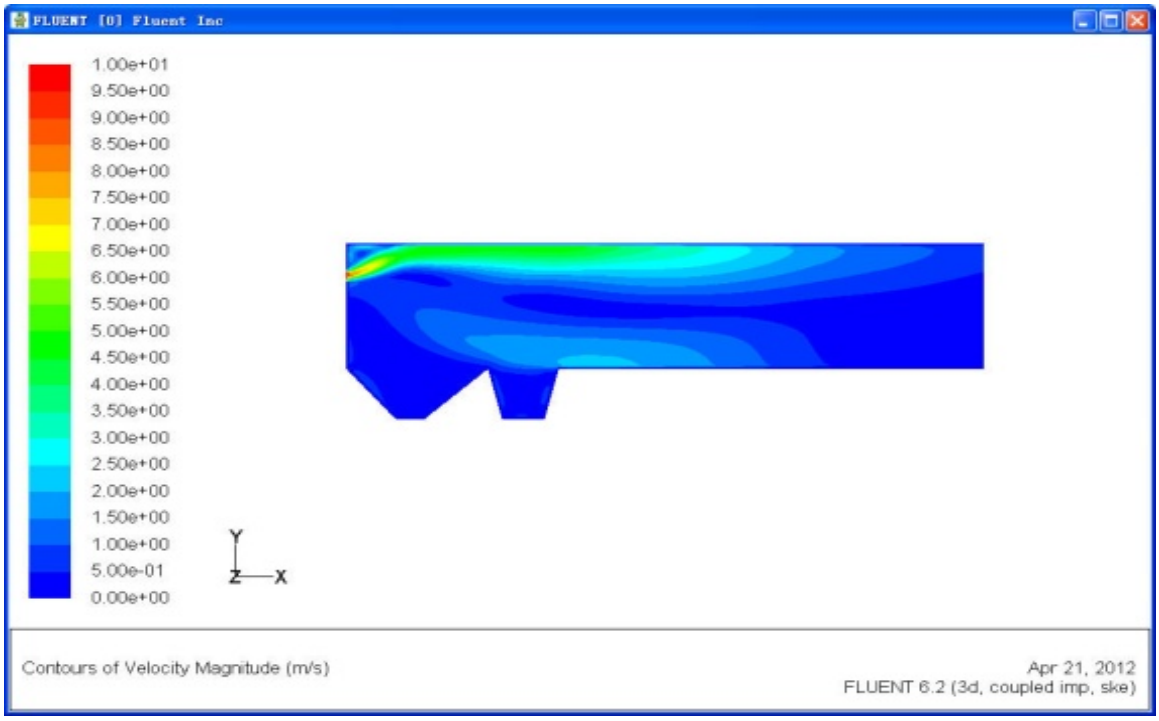


(a) Wind velocity is 8m/s



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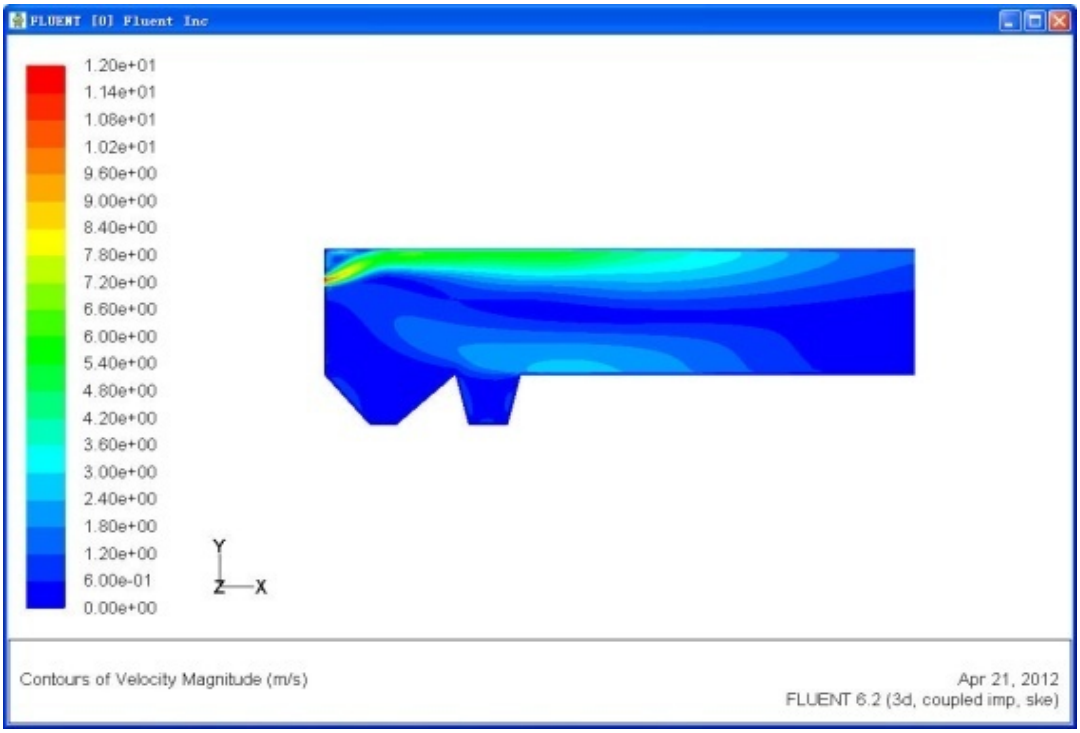

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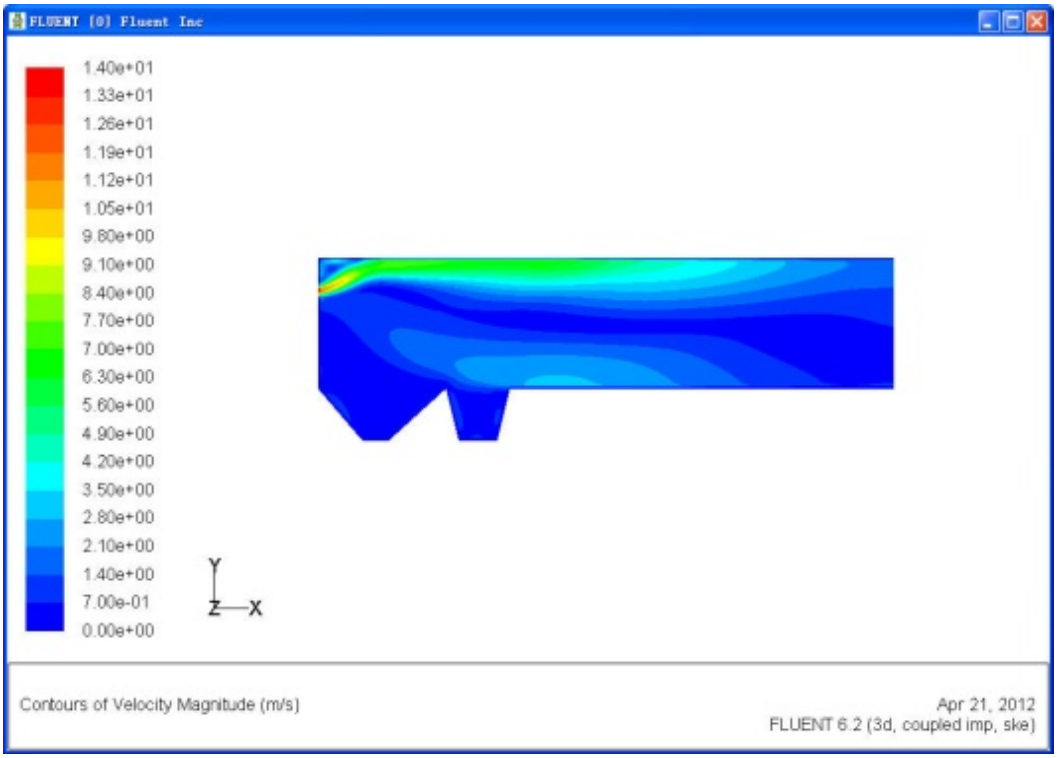
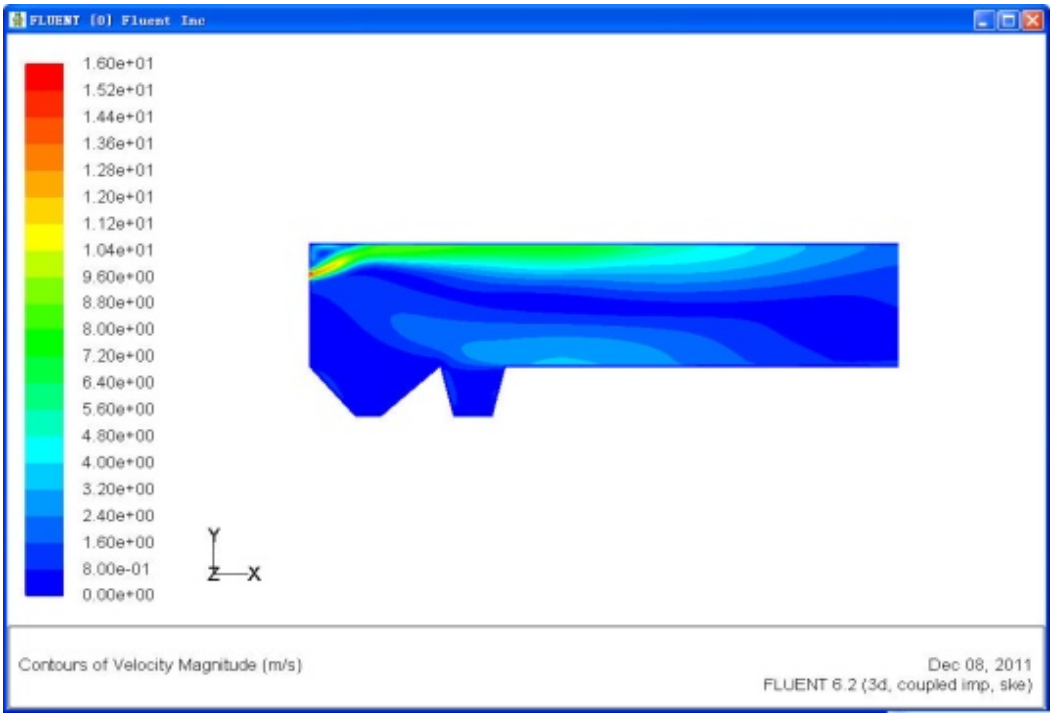
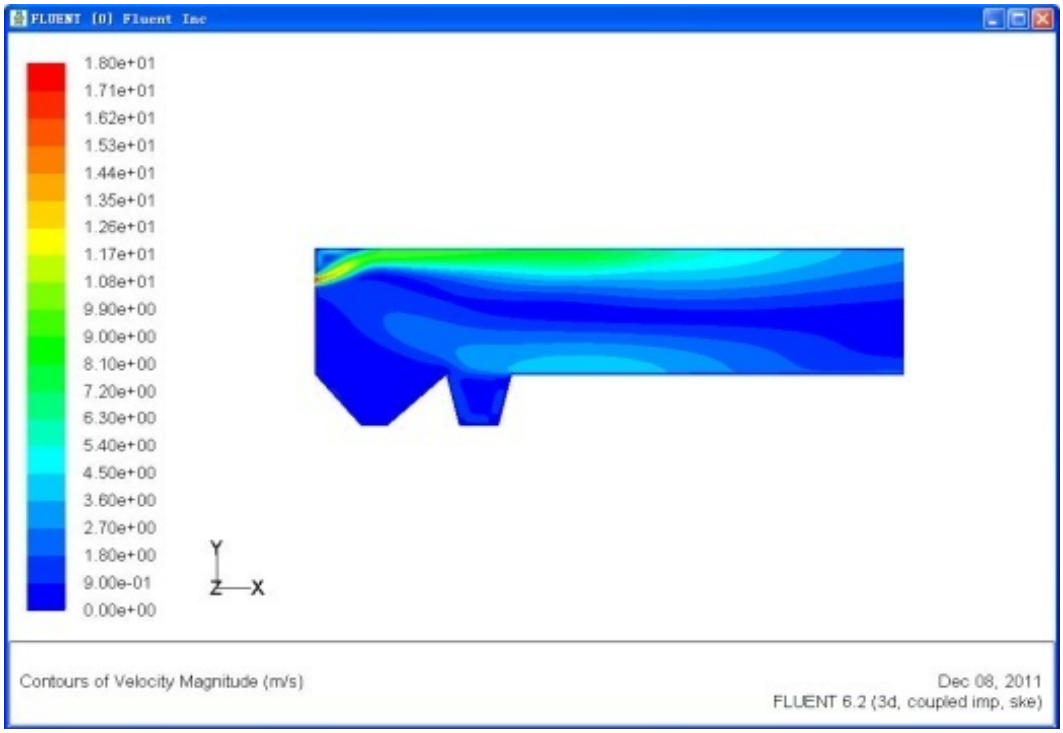


(d) Wind velocity is 14m/s

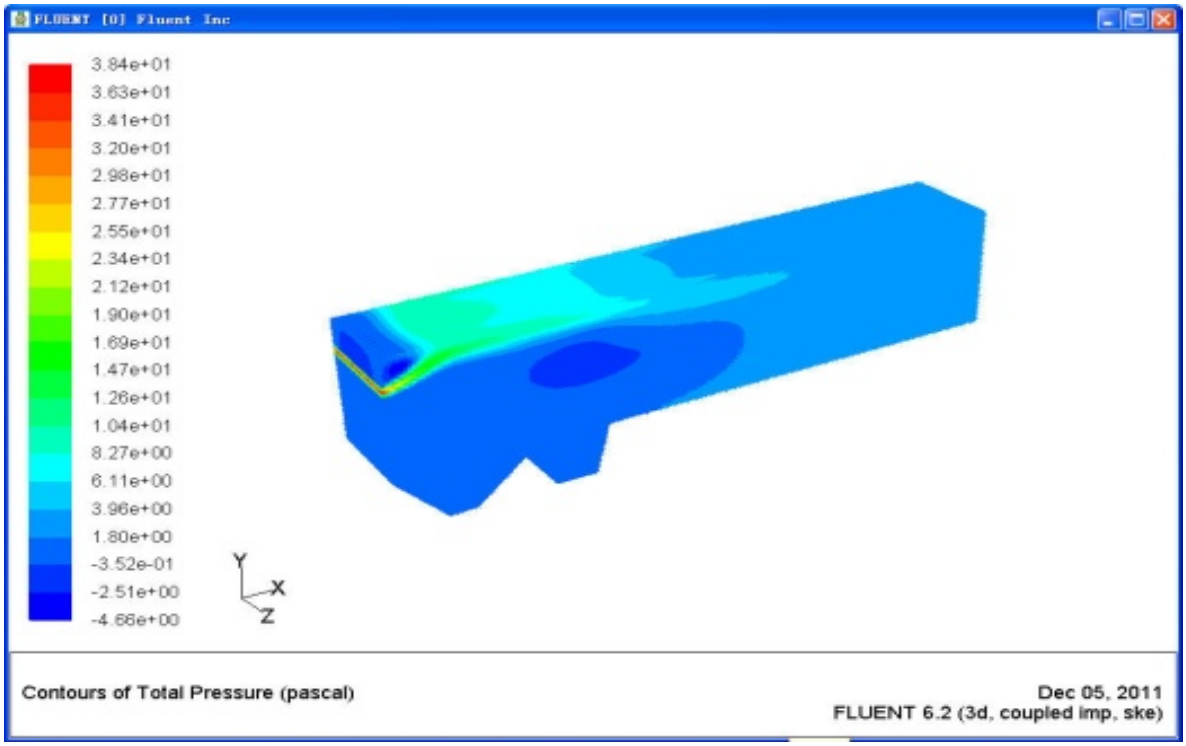


(e) Wind velocity is 16m/s



(f) Wind velocity is 18m/s

Fig. 1: Simulation results of equipotential velocity distribution in internal flow field when intake angle is 15°



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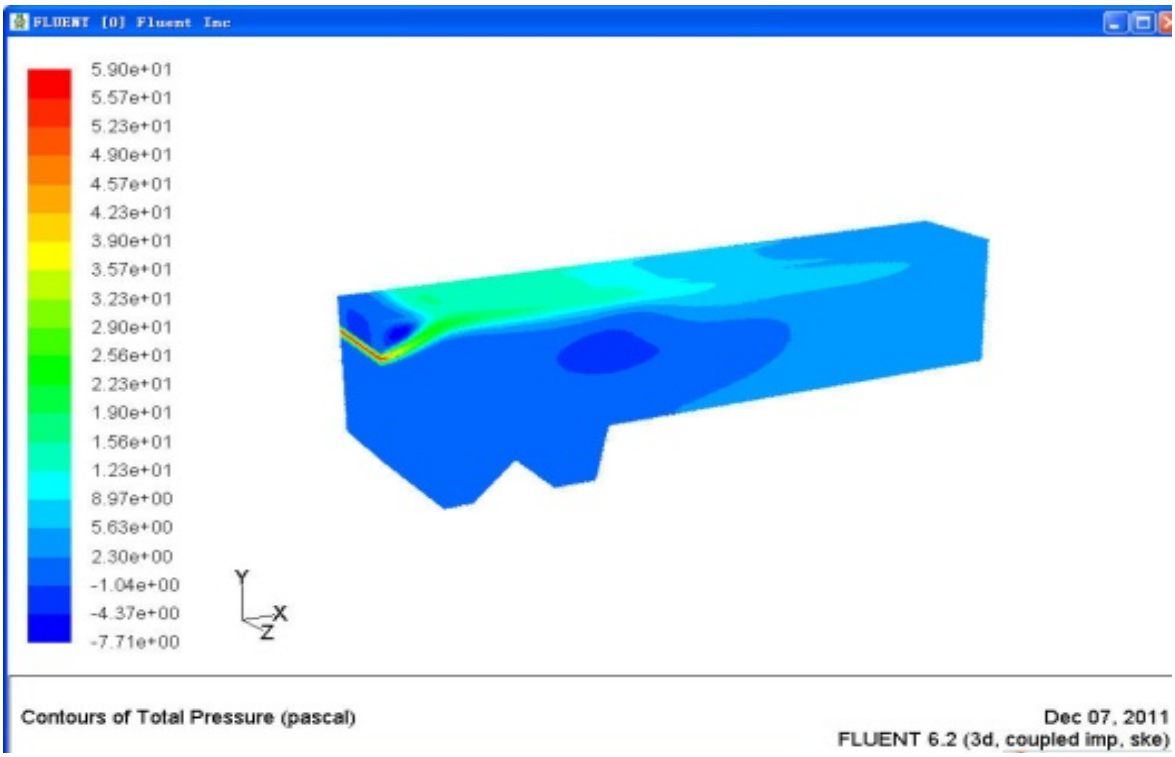

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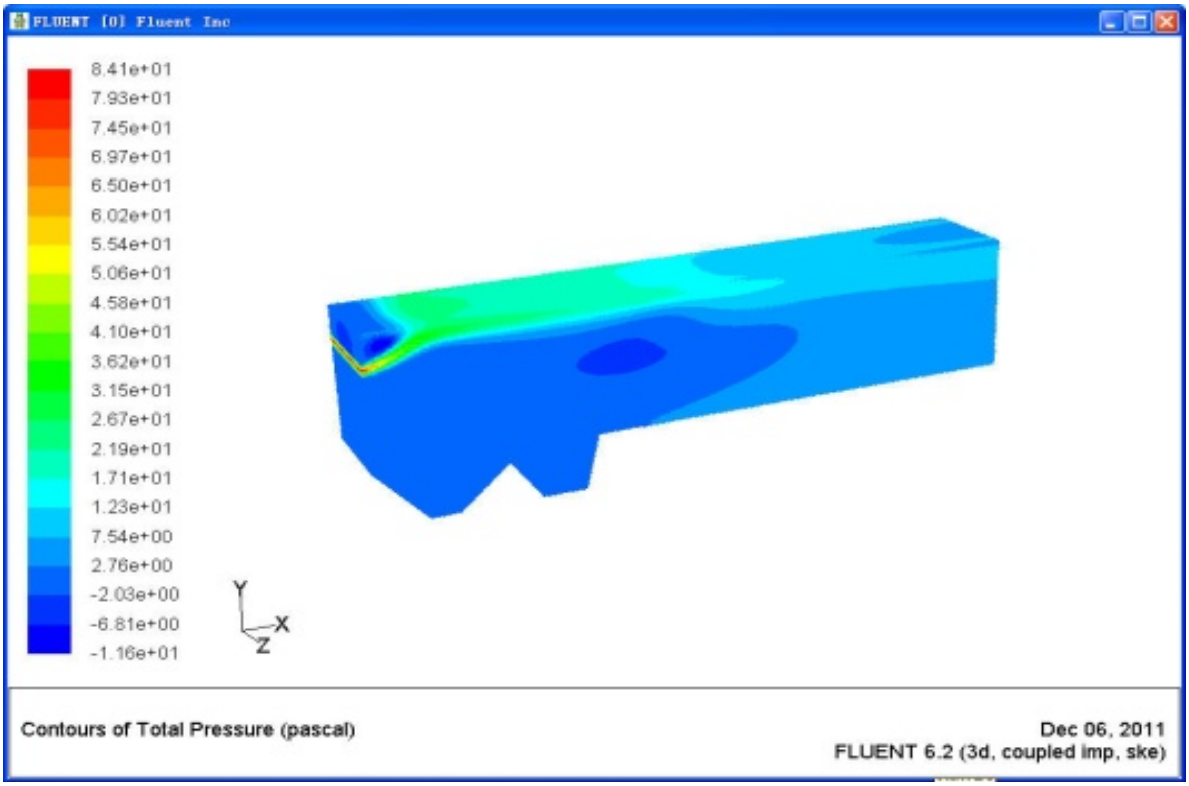

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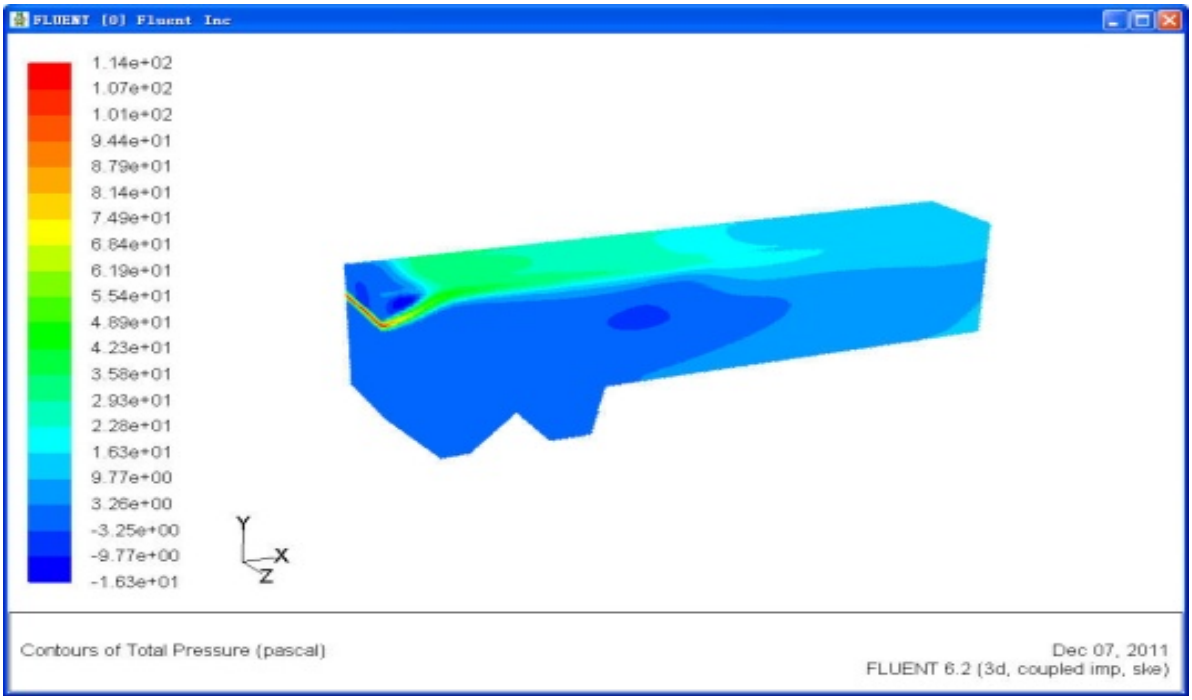

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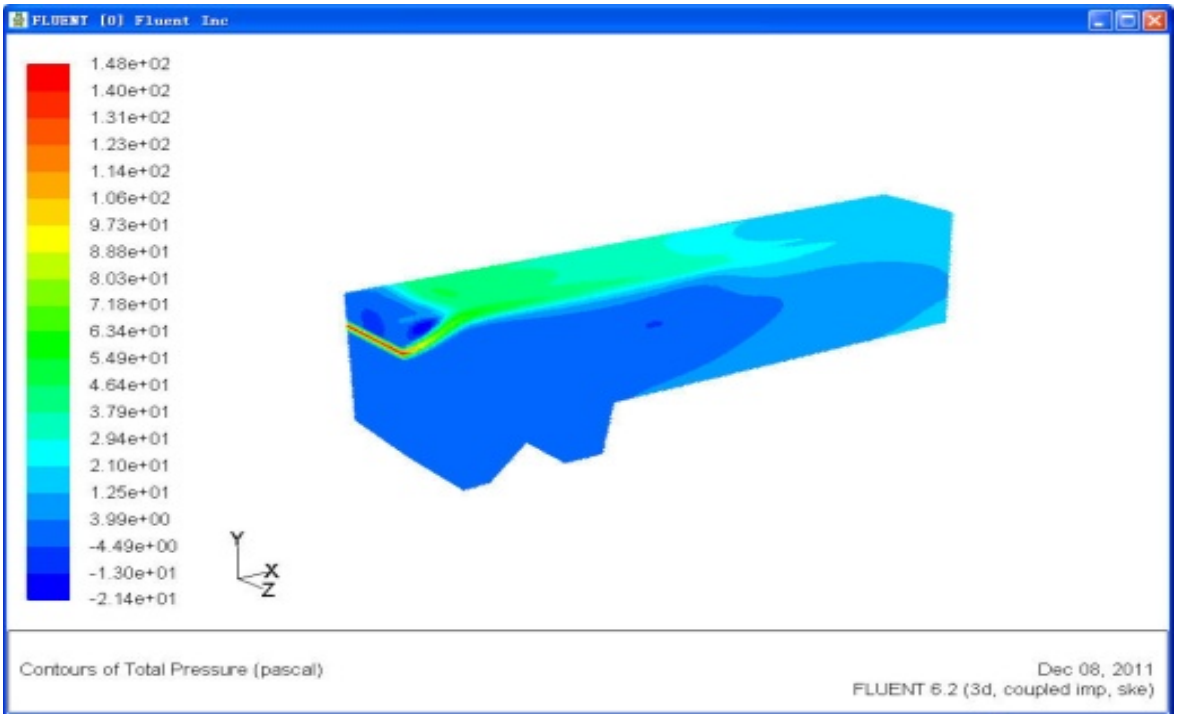
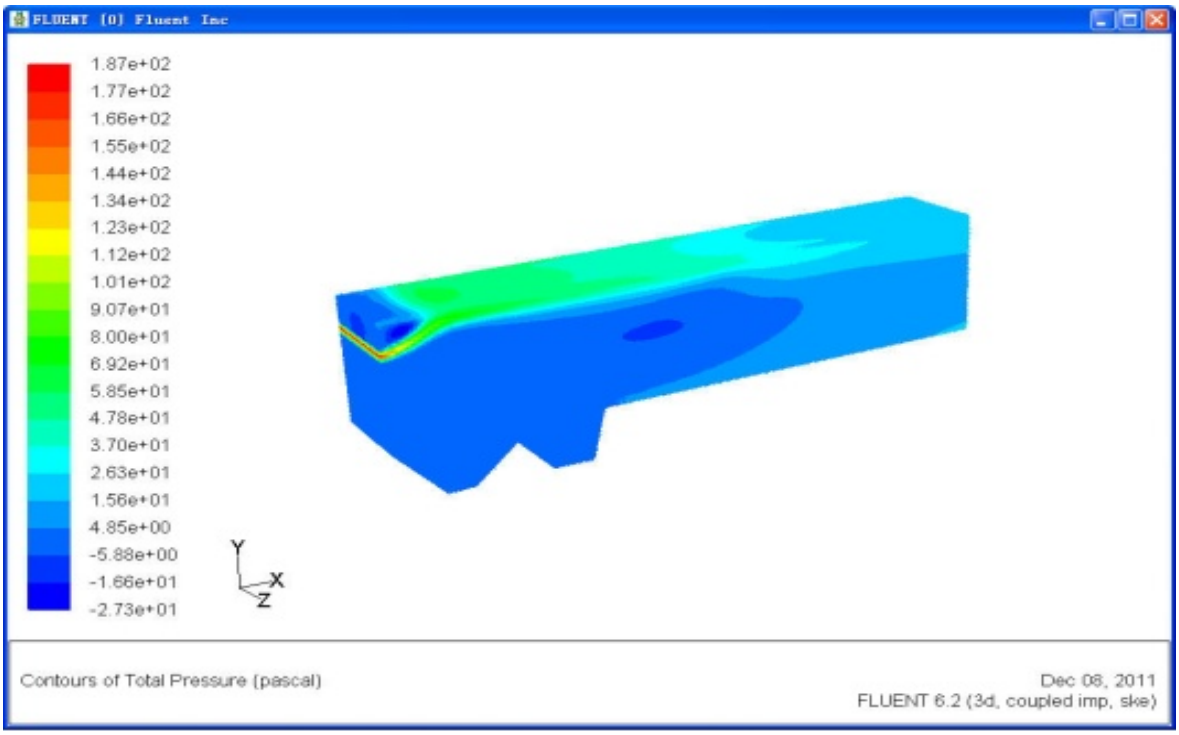


(e) Wind velocity is 16m/s



(f) Wind velocity is 18m/s

Fig. 2: Simulation results of pressure distribution in internal flow field when intake angle is 15°

and the high separation purity quotient of plastic and paper is. But separation efficiency becomes low.

SIMULATION AND ANALYSIS ON INTERNAL FLOW FIELD AT DIFFERENT WIND VELOCITY

Simulation and analysis on equipotential velocity distribution at different wind velocity: Known from Fig. 1, after air flow enters into separating system, velocity of top region is bigger. High velocity region is formed along the top surface and low velocity region is formed at the top of light substance groove and its right. With the increasing of wind velocity, plastic and paper will obtains greater momentum and horizontal moving distance becomes longer. Rotational flow region begins to form in upper part of light substance groove.

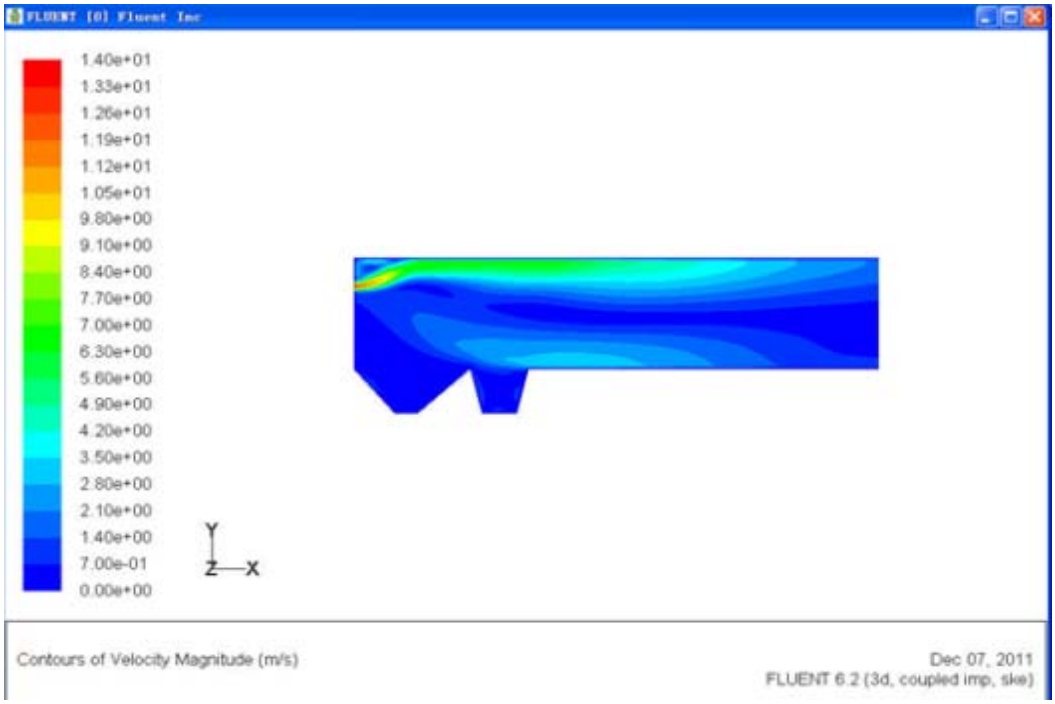
Simulation and analysis on pressure distribution at different wind velocity: Known from Fig. 2, the characteristics of pressure distribution when intake angle is 15° are concluded as follow:

- The maximum pressure locates in intake opening. Flow will be diffuse after entering into separating system, but mainly moves to the right along top.
- With the increasing of wind velocity, pressure and acting force of flow to plastic and paper become bigger and horizontal moving distance is longer.
- Low pressure region is formed at left lower part of internal flow field and air flows to this region from right high pressure region.

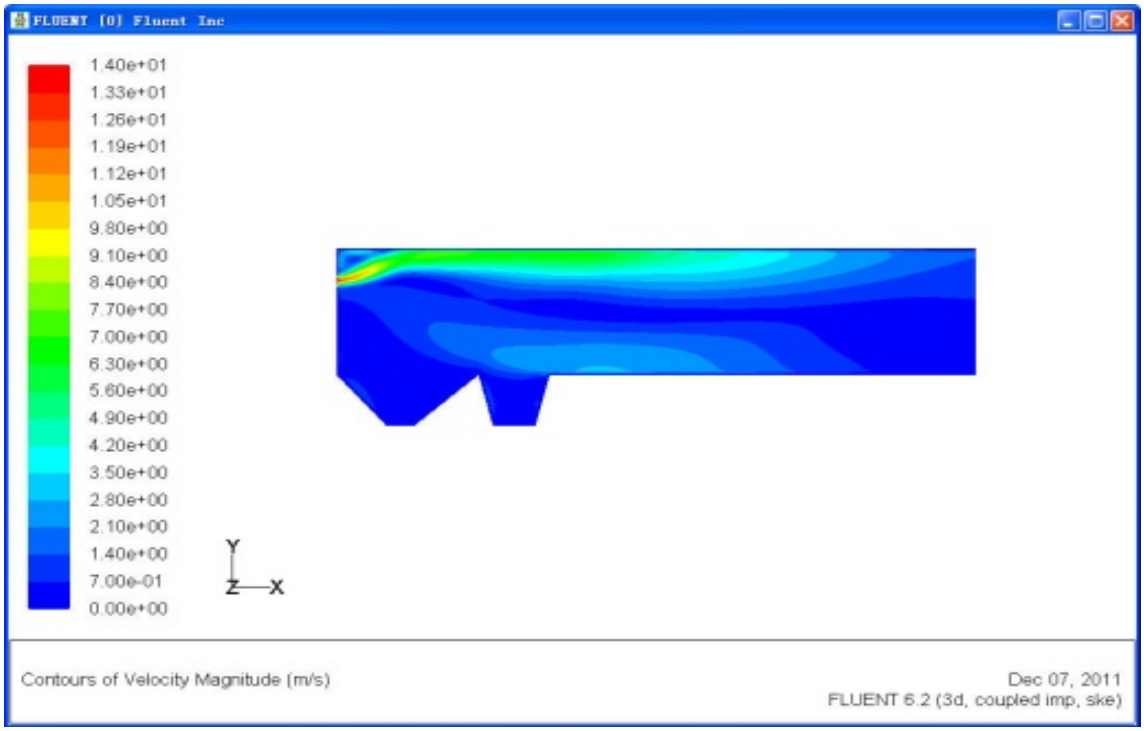
Rotational flow is formed. With the increasing of wind velocity, relative low pressure region enlarges. High pressure region reduces and moves to the right. The region and strength of rotational flow increases and it leads to low separation's purity quotient and efficiency of plastic and paper.

SIMULATION AND ANALYSIS OF INTERNAL FLOW FIELD AT DIFFERENT INTAKE ANGLE

Simulation and analysis on equipotential velocity distribution at different intake angle: Known from Fig. 3, the maximum flow velocity locates in intake opening. With the increasing of intake angle, horizontal component of wind velocity decreases continuously and horizontal acting force of flow to solid material reduces. Moving distance of plastic and paper is short and it leads to worse separating effect. But vertical component of wind velocity increases accordingly and the dropping time is lengthened. It is good for increasing purity quotient of separation.



(a) Intake angle is 5°



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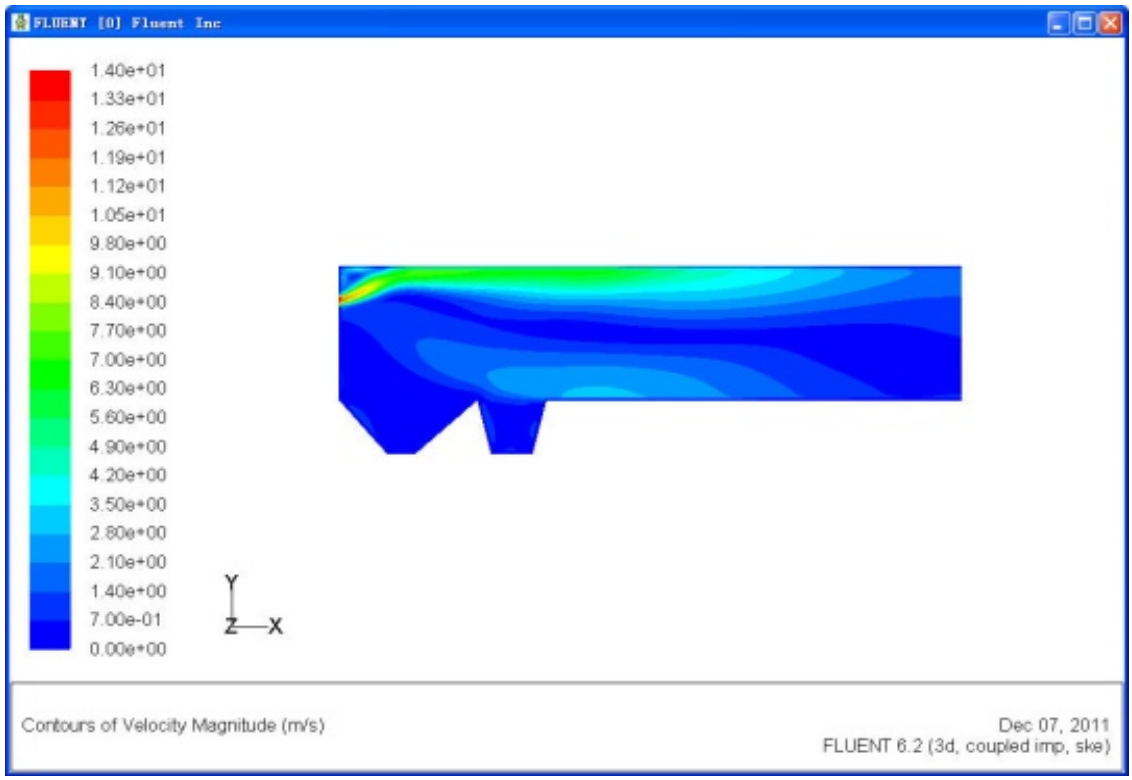
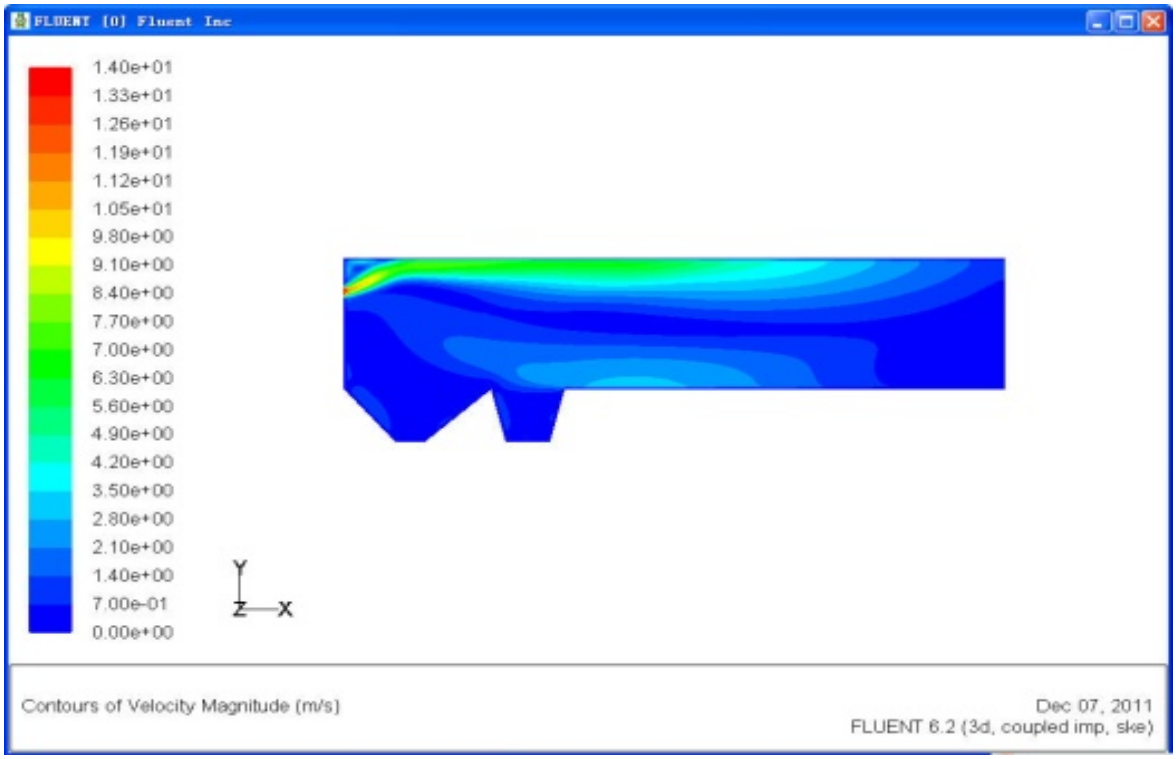
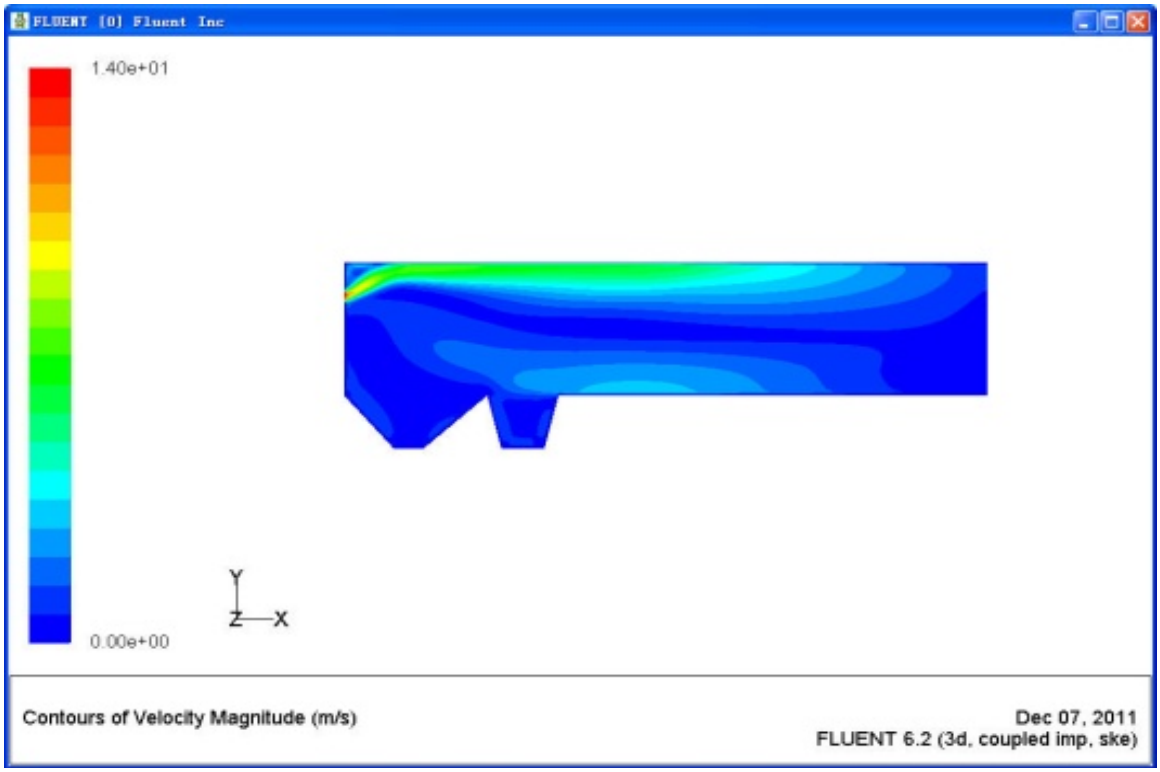


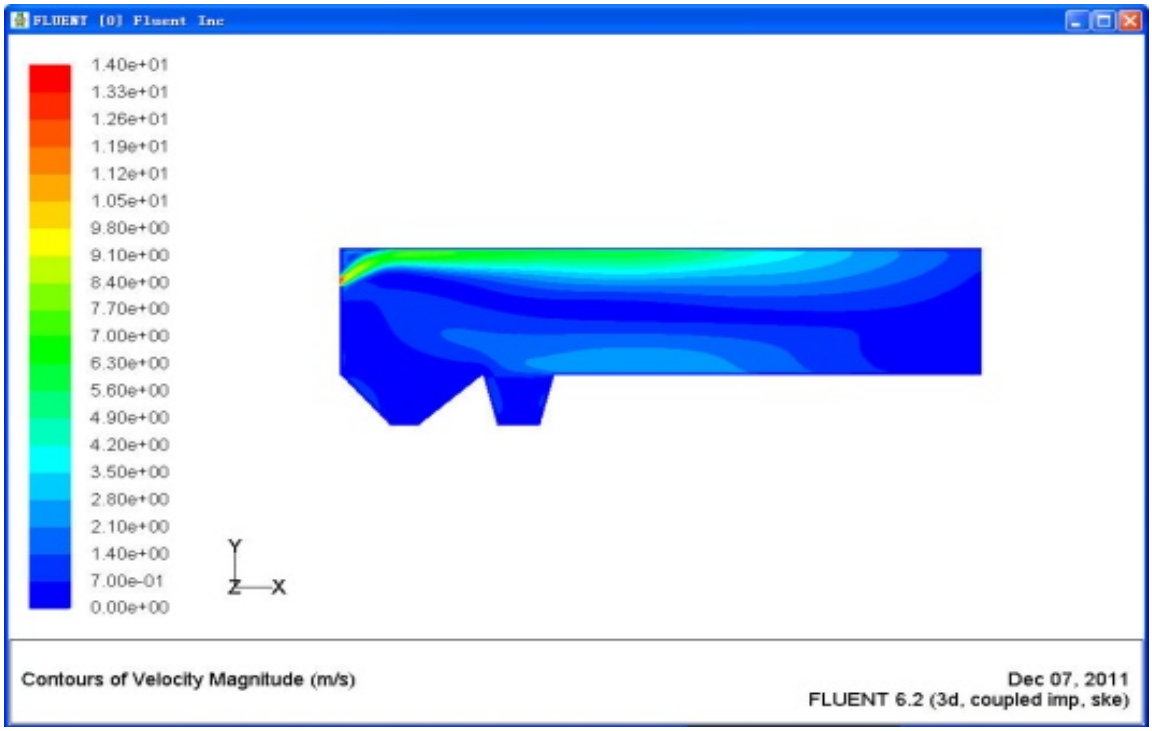
(c) Intake angle is 15°



(d) Intake angle is 20°

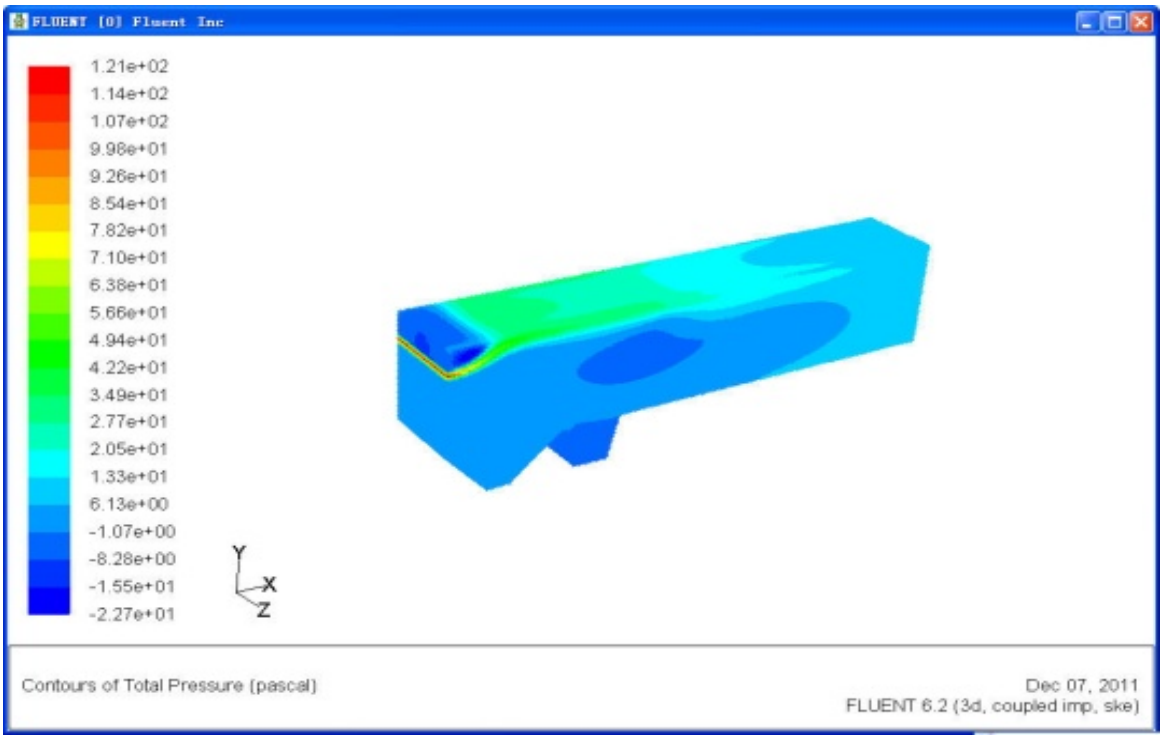


(e) Intake angle is 20°

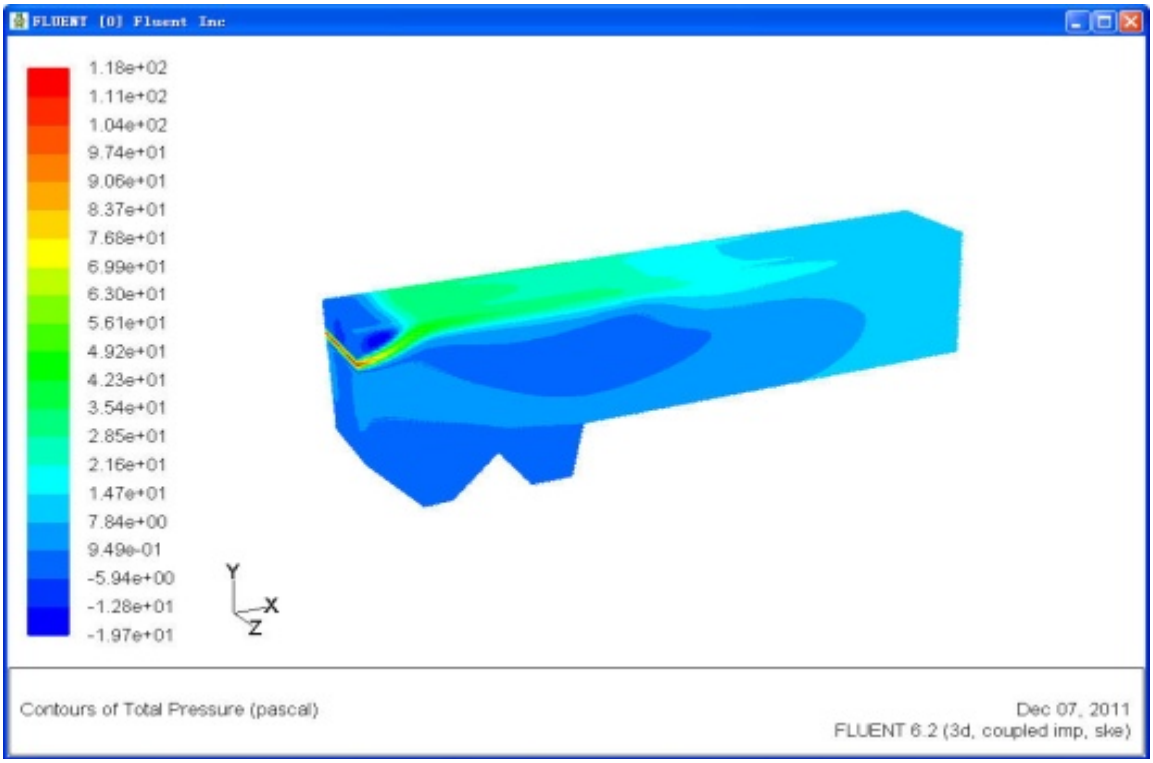


(f) Intake angle is 30°

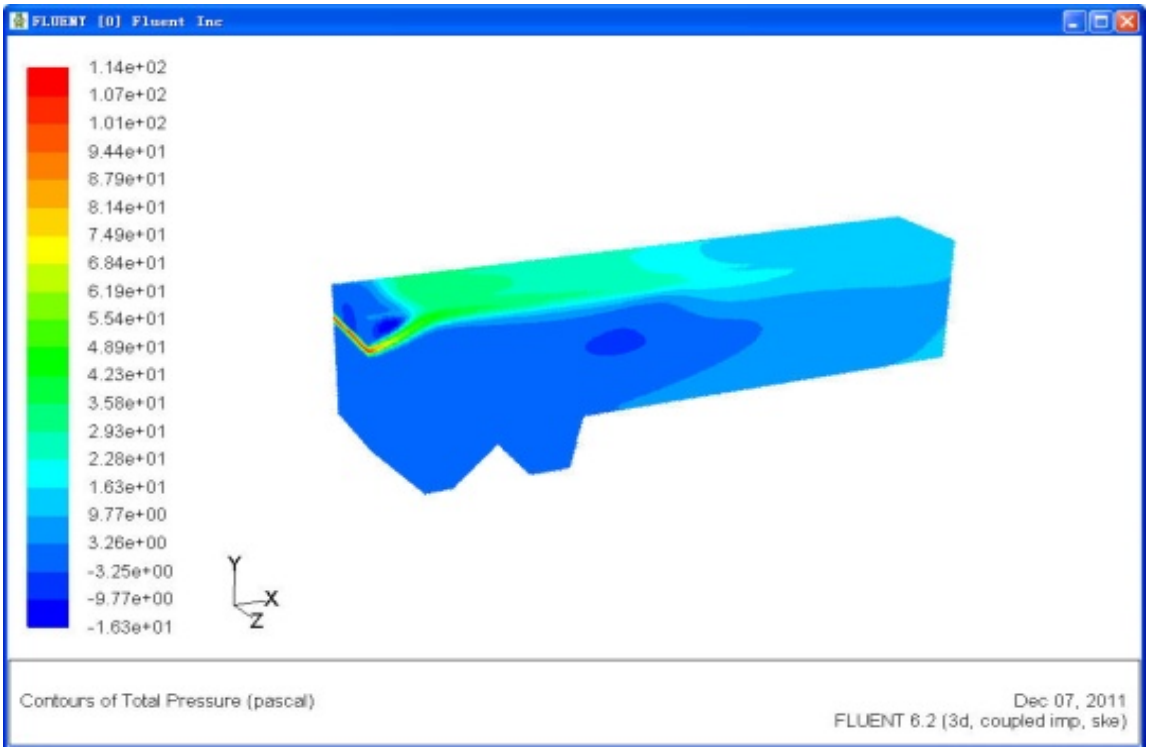
Fig. 3: Simulation results of equipotential velocity distribution in flow field when wind velocity is 14m/s



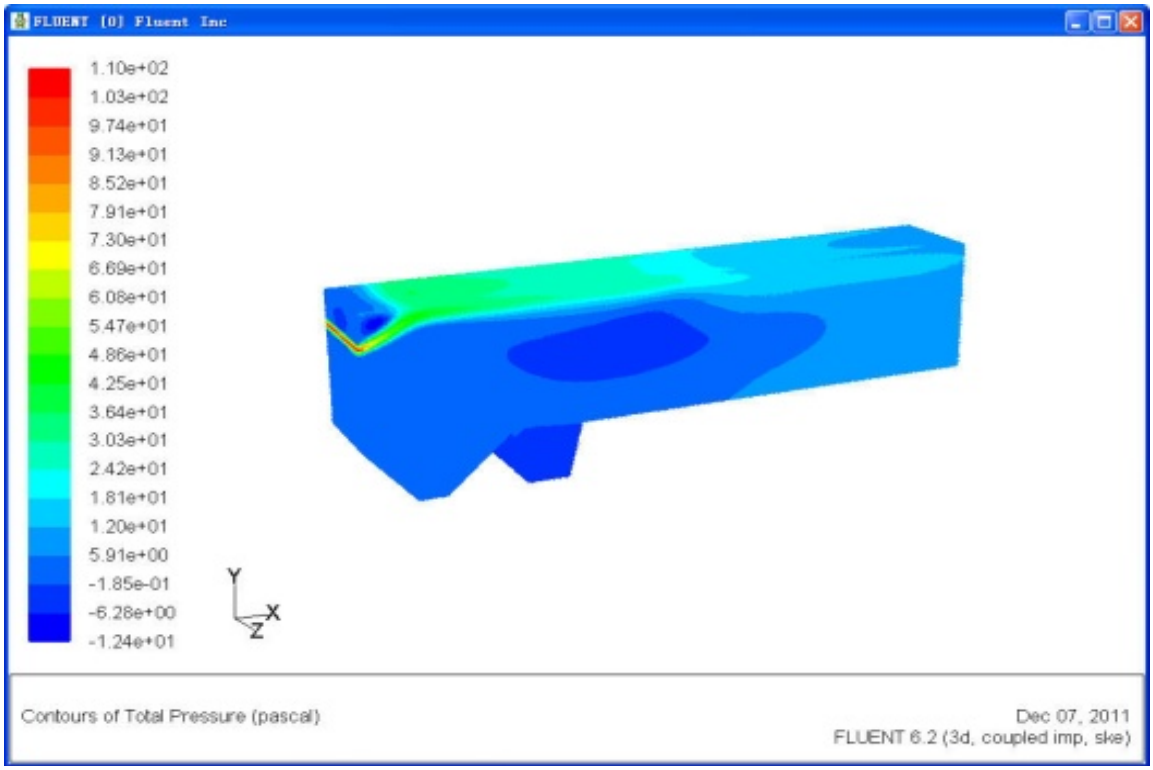
(a) Intake angle is 5°



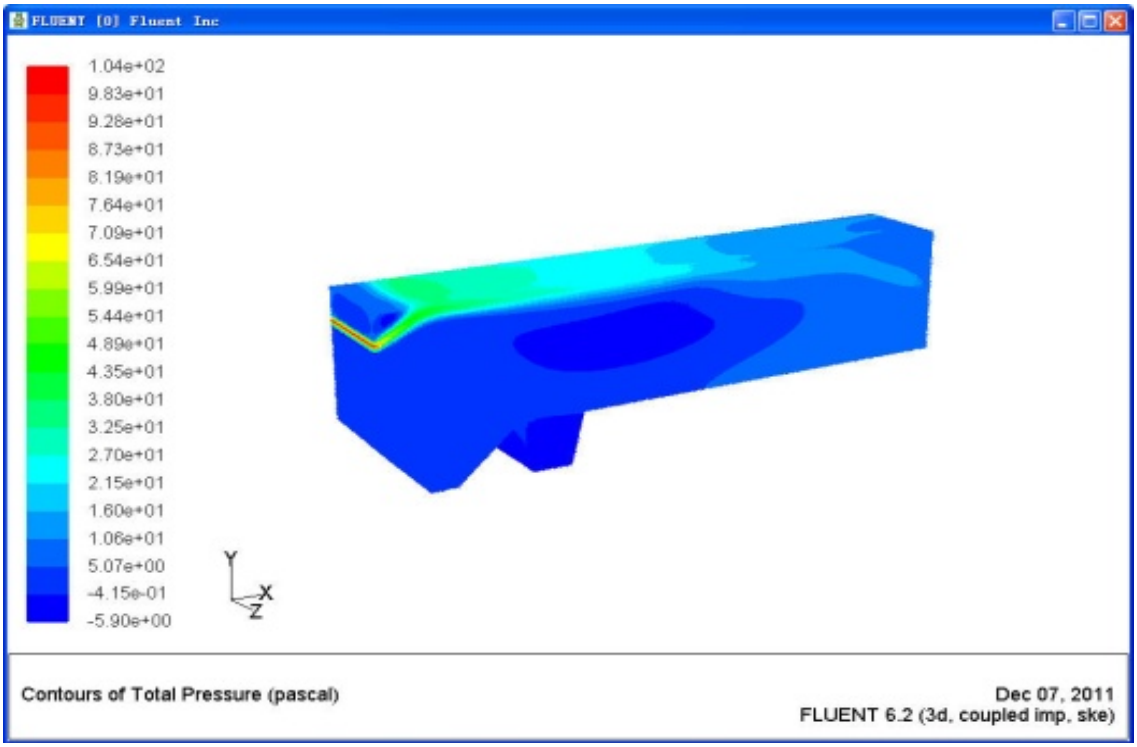
(b) Intake angle is 10°



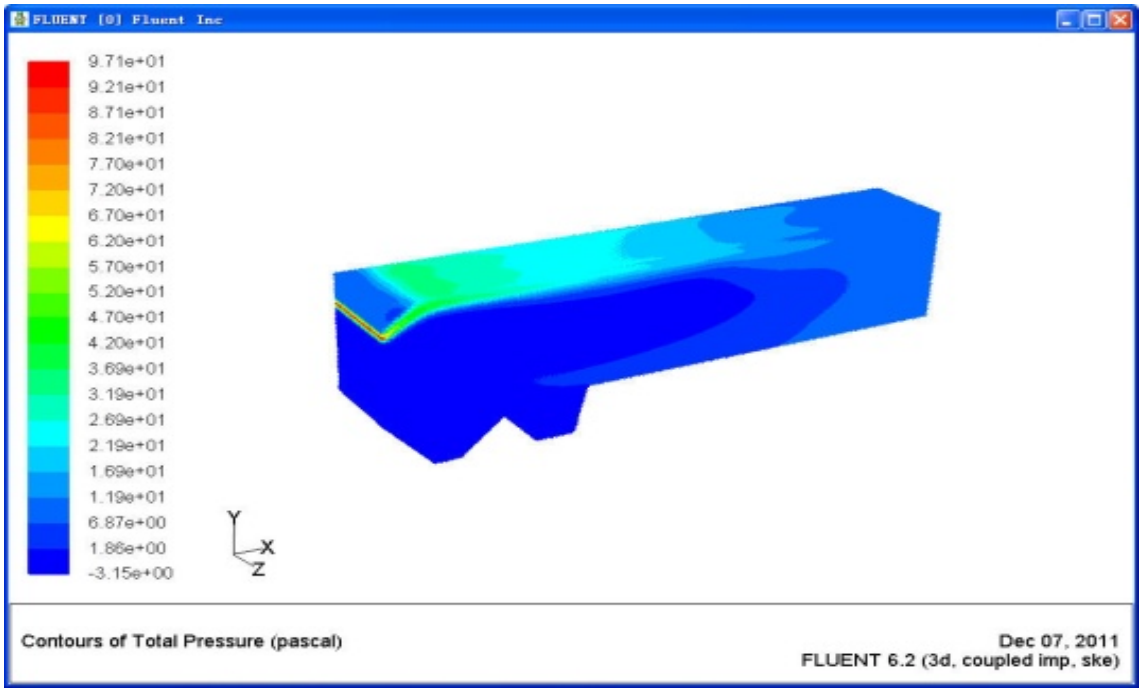
(c) Intake angle is 15°



(d) Intake angle is 20°



(e) Intake angle is 20°



(f) Intake angle is 30°

Fig. 4: Simulation results of pressure distribution in flow field when wind velocity is 14m/s

Simulation and analysis on pressure distribution at different intake angle: Known from Fig. 4, the characteristics of pressure distribution when wind velocity is 14m/s are concluded as follow. With the increasing of intake angle, relative low-pressure region is formed gradually at the top of light substance groove and its range enlarges continuously. Rotational flow is formed. When intake angle is greater than 20°, the strength of rotational flow enlarges and it leads to low separating effective.

CONCLUSION

When intake angle and wind velocity is little, it is difficult for plastic and paper to reach to the upper part of light substance groove and leads to low separating effective. With the increasing air-intake angle, vertical component of wind velocity increases accordingly. Dropping velocity decreases and separating time elongates effectively. Separating purity quotient rises at the first and then falls. With the longer of separating time, separating efficiency decreases. When intake angle is greater than 15°, rotational flow occurs at the upper part of substance groove. With the increasing air-intake angle and wind velocity, relative low pressure region enlarges and relative high pressure region reduces and moves to the right. The region and strength of rotational flow increases and it leads to low separating effect.

Considered generally, to the spring urban garbage of North cities in China, better separation's purity quotient and efficiency of plastic and paper can be obtained when air-intake angle is between 15-20° and wind velocity is between 12-14 m/s.

ACKNOWLEDGMENT

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