JOURNAL OF MULTIDISCIPLINARY SCIENCES AND INNOVATIONS

VOLUME 5, ISSUE 02
MOPNTHLY JOURNALS

ISSN NUMBER: 2751-4390
IMPACT FACTOR: 9,08

MIXED (COMBINED) VENTILATION SCHEMES IN OPEN-PIT MINES

F. R. Usmonov
Asia International University Lecturer of the
"General Technical Sciences" Department

Annotation: This article explores the ventilation of open-pit mines under the combined influence of wind energy and thermal forces. It discusses how air movement forms differently in shallow versus deep horizons, highlighting direct-flow convective and convective–inversion ventilation schemes. The relationship between the real and adiabatic temperature gradients is analyzed, demonstrating its impact on the efficiency of pollutant removal. The study emphasizes that increased atmospheric stability complicates ventilation, reducing both airflow and pollutant extraction.

Keywords: Open-pit mine ventilation, mixed ventilation scheme, convective airflow, inversion airflow, wind energy effects, thermal forces, quarry atmosphere, air circulation in deep pits, temperature gradient, adiabatic gradient, atmospheric stability, pollutant dispersion, turbulent diffusion, airflow dynamics, natural ventilation, convective heat transfer, recirculating airflow, environmental safety in mining, large-scale blasting emissions, air exchange efficiency.

Introduction: When the wind speed at the surface is 2–5 m/s, air movement in an open pit is formed as a result of the combined influence of wind energy and thermal forces acting on the quarry atmosphere.

In deep open pits, a ventilation scheme based on the combination of wind and thermal forces is often used. Experiments show that even when the surface wind flow is strong, its influence with depth does not exceed 150–200 meters. Below this depth, wind energy has almost no effect on the formation of air movement.

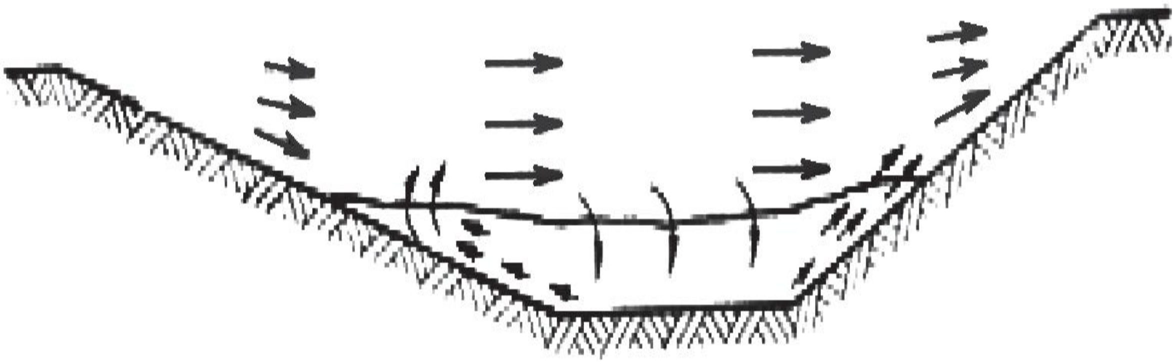

Figure 1 – Direct-flow convective ventilation scheme of an open pit.

Air movement in the deep horizons of an open pit is formed under the influence of thermal forces. In these deep horizons, air circulation may be convective or inversion in nature. In a direct convective air movement pattern, the upper part of the quarry atmosphere is ventilated by wind energy, while the lower part is ventilated by convective thermal forces (Figure 1). In this process, harmful substances are lifted upward by convective flows, enter the zone influenced by the direct wind stream, and are then carried out of the quarry.

If one wall of the open pit is cold while the other is heated for some reason (for example, due to combustion of minerals on the slope), air movement may develop under the combined action of convective and inversion schemes (Figure 2).

JOURNAL OF MULTIDISCIPLINARY SCIENCES AND INNOVATIONS
VOLUME 5, ISSUE 02
MOPNTHLY JOURNALS
ISSN NUMBER: 2751-4390
IMPACT FACTOR: 9,08

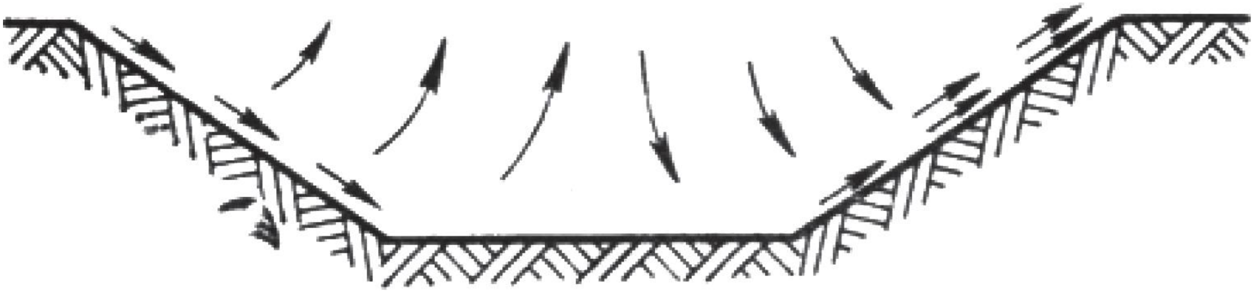

Figure 2 – Convective–inversion ventilation scheme of an open pit.

In practice, the combined influence of wind and thermal forces is most commonly observed in the natural ventilation of open pits. Under such conditions, a wind-driven air movement pattern (either direct-flow or recirculating) is formed within the quarry. In this case, vertical air motion may intensify (when the actual temperature gradient exceeds the adiabatic gradient) or weaken (when the actual temperature gradient is lower than the adiabatic gradient).

To remove harmful substances released into the quarry atmosphere at one moment (for example, during large-scale blasting) through prolonged ventilation — assuming the same initial concentration of pollutants — the following relationship exists between adiabatic and real atmospheric conditions:

$Q_p = n \cdot Q_a$,

Here, Q_p is the turbulent diffusion coefficient of the free jet ventilating the quarry under real atmospheric conditions; Q_a is the corresponding value for an adiabatic atmosphere; and n is a coefficient that accounts for the negative temperature gradient of the air in the quarry (calculated individually for each set of conditions).

When the real adiabatic air gradient is very high ($G_r > 1$°C per 100 m), the coefficient $n > 1$ and $Q_p > Q_a$. This means that the actual volume of air required to ventilate the quarry (Q_p) exceeds the calculated air demand (Qa). When the real gradient is lower than the adiabatic gradient ($G_r < 1$°C per 100 m), $n < 1$ and $Q_p < Qa$, meaning that the actual ventilation air volume is less than the calculated value. For quarries with a large negative temperature gradient, n may reach 2.5–3.

When the real atmosphere is unstable ($G_r > 1$°C per 100 m), $Q_p > Q_a$, indicating that the removal of harmful substances from the quarry occurs more intensively. Conversely, under stable atmospheric conditions ($G_r < 1$°C per 100 m), $Q_p < Q_a$, and the removal process becomes less intense.

Thus, under the combined action of wind energy and thermal forces, the removal of harmful substances from the quarry becomes more difficult as the vertical temperature gradient decreases. In summary, an increase in atmospheric stability within the quarry (that is, a reduction in the temperature gradient) makes ventilation more difficult — both by reducing the inflow of fresh air and by worsening the conditions for removing harmful substances from the quarry.

List of References.

1. Usmonov, F. R. (2025). KARYER ATMOSFERASIDAGI ZARARLI GAZLARLARNI NEYTRALIZATSIYALASH CHORA TADBIRLARI. *Recent scientific discoveries and methodological research*, *2*(6), 33-39.
2. Usmonov, F. R. (2025). KARYERLARDA BURG ‘ILAB–PORTLATISH ISHLARIDA ATMOSFERA CHANGLANISHINI KAMAYTIRISH MEXANIZMLARI. *Science, education, innovation: modern tasks and prospects*, *2*(6), 44-51.

3. Usmonov, F. R. (2025). KON MASSASINI TASHISH JARAYONLARIDA KARYER ATMOSFERASIGA CHANG AJRALISHINI KAMAYTIRISH. *Modern World Education: New Age Problems–New solutions*, *2*(6), 17-25.
4. Usmonov, F. R. (2025). KARYERDA QAZIB-YUKLASH ISHLARIDA ATMOSFERASI CHANGLANISHINI KAMAYTIRISH CHORA TADBIRLARI. *Modern World Education: New Age Problems–New solutions*, *2*(6), 40-47.
5. Usmonov, F. R. (2025). KARYERLARDA PORTLATISH ISHLARINI OLIB BORISHDA CHANG AJRALIB CHIQISHINI KAMAYTIRISH SAMARADORLIGINI OSHIRISH. *Modern World Education: New Age Problems–New solutions*, *2*(6), 67-73.
6. Usmonov, F. R. (2025). FOYDALI QAZILMALARNI OCHIQ USULDA QAZIB OLISHDA KARYER HAVOSIDAGI PORTLOVCHI GAZSIMON ARALASHMALAR. *Introduction of new innovative technologies in education of pedagogy and psychology*, *2*(5), 98-105.
7. Usmonov, F. R. (2025). FOYDALI QAZILMALAR OCHIQ USULDA QAZIB OLISHDA KARYER HAVOSI VA UNING ASOSIY TARKIBI. *Introduction of new innovative technologies in education of pedagogy and psychology*, *2*(5), 83-89.
8. Usmonov, F. R. (2025). KARYERLARDA QO'LLANILADIGAN CHANG BOSTIRISH USULLARI. *Introduction of new innovative technologies in education of pedagogy and psychology*, *2*(5), 68-74.
9. Usmonov, F. R. (2025). KARYER ATMOSFERASINI NORMALLASHTIRISH VOSITALARI. *Introduction of new innovative technologies in education of pedagogy and psychology*, *2*(5), 34-41.
10. Usmonov, F. R. (2025). FOYDALI QAZILMALAR OCHIQ USULDA QAZIB OLISHDA KARYER ATMOSFERASINI IFLOSLANTIRISH MANBALARI. *Introduction of new innovative technologies in education of pedagogy and psychology*, *2*(5), 12-17.