Table S1 Output data (Bold indicates baseline condition, W\*: mean value during winter).

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Ventilation condition | Variable | | Fixed values | Total operational cost ($) | Inhalable dust (mg/m3) | | | | Respirable dust (mg/m3) | | | | Humidity (kg/m3) | NH3 (ppm) | CO (ppm) | | | | CO2 (ppm) | | | |
| 7AM-3PM | 3PM-11PM | 11PM-7AM | W\* | 7AM-3PM | 3PM-11PM | 11PM-7AM | W\* | W\* | W\* | 7AM-3PM | 3PM-11PM | 11PM-7AM | W\* | 7AM-3PM | 3PM-11PM | 11PM-7AM | W\* |
| Pit fans only | Pit fan | 1 pit fan | Medium cold Wall insulation: 0.286 W/m2∙K Pit-air-exchange ratio: 0.1  Inhalable dust: 1.39 mg/s  Respirable dust: 0.14 mg/s | 472 | 3.70 | 3.30 | 3.11 | 3.37 | 0.38 | 0.34 | 0.32 | 0.35 | 7.13 | 0.35 | 0.08 | 0.09 | 0.21 | 0.13 | 2011 | 2032 | 2258 | 2101 |
| 2 pit fans | 1088 | 1.85 | 1.65 | 1.55 | 1.68 | 0.19 | 0.17 | 0.16 | 0.17 | 3.56 | 0.17 | 0.28 | 0.29 | 0.40 | 0.32 | 1656 | 1685 | 1902 | 1748 |
| Outdoor temperature | Mild cold | 2 pit fans  Wall insulation: 0.286 W/m2∙K Pit-air-exchange ratio: 0.1  Inhalable dust: 1.39 mg/s  Respirable dust: 0.14 mg/s | 872 | 1.85 | 1.65 | 1.55 | 1.68 | 0.19 | 0.17 | 0.16 | 0.17 | 3.56 | 0.17 | 0.18 | 0.19 | 0.31 | 0.22 | 1468 | 1497 | 1714 | 1560 |
| Medium cold | 1088 | 1.85 | 1.65 | 1.55 | 1.68 | 0.19 | 0.17 | 0.16 | 0.17 | 3.56 | 0.17 | 0.28 | 0.29 | 0.40 | 0.32 | 1656 | 1685 | 1902 | 1748 |
| Extremely cold | 1304 | 1.85 | 1.65 | 1.55 | 1.68 | 0.19 | 0.17 | 0.16 | 0.17 | 3.56 | 0.17 | 0.37 | 0.39 | 0.50 | 0.42 | 1844 | 1873 | 2090 | 1936 |
| Wall insulation (W/m2∙K) | 0.2 | 2 pit fans  Medium cold Pit-air-exchange ratio: 0.1  Inhalable dust: 1.39 mg/s  Respirable dust: 0.14 mg/s | 1064 | 1.85 | 1.65 | 1.55 | 1.68 | 0.19 | 0.17 | 0.16 | 0.17 | 3.56 | 0.17 | 0.27 | 0.28 | 0.39 | 0.31 | 1638 | 1666 | 1879 | 1728 |
| 0.286 | 1088 | 1.85 | 1.65 | 1.55 | 1.68 | 0.19 | 0.17 | 0.16 | 0.17 | 3.56 | 0.17 | 0.28 | 0.29 | 0.40 | 0.32 | 1656 | 1685 | 1902 | 1748 |
| 0.3 | 1092 | 1.85 | 1.65 | 1.55 | 1.68 | 0.19 | 0.17 | 0.16 | 0.17 | 3.56 | 0.17 | 0.28 | 0.29 | 0.41 | 0.32 | 1660 | 1689 | 1906 | 1751 |
| 0.4 | 1119 | 1.85 | 1.65 | 1.55 | 1.68 | 0.19 | 0.17 | 0.16 | 0.17 | 3.56 | 0.17 | 0.29 | 0.30 | 0.42 | 0.34 | 1681 | 1711 | 1933 | 1775 |
| Pit-air-exchange ratio | 0.01 | 2 pit fans  Medium cold Wall insulation: 0.286 W/m2∙K  Inhalable dust: 1.39 mg/s  Respirable dust: 0.14 mg/s | 1083 | 1.85 | 1.65 | 1.55 | 1.68 | 0.19 | 0.17 | 0.16 | 0.17 | 3.56 | 0.02 | 0.27 | 0.29 | 0.40 | 0.32 | 1631 | 1660 | 1877 | 1723 |
| 0.10 | 1088 | 1.85 | 1.65 | 1.55 | 1.68 | 0.19 | 0.17 | 0.16 | 0.17 | 3.56 | 0.17 | 0.28 | 0.29 | 0.40 | 0.32 | 1656 | 1685 | 1902 | 1748 |
| 0.20 | 1093 | 1.85 | 1.65 | 1.55 | 1.68 | 0.19 | 0.17 | 0.16 | 0.17 | 3.56 | 0.32 | 0.28 | 0.29 | 0.41 | 0.33 | 1681 | 1710 | 1926 | 1773 |
| 0.30 | 1097 | 1.85 | 1.65 | 1.55 | 1.68 | 0.19 | 0.17 | 0.16 | 0.17 | 3.56 | 0.44 | 0.28 | 0.29 | 0.41 | 0.33 | 1701 | 1730 | 1947 | 1793 |

(Continue to next page)

(Continue from Table S1)

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Ventilation condition | Variable | | Fixed values | Total operational cost ($) | Inhalable dust (mg/m3) | | | | Respirable dust (mg/m3) | | | | Humidity (kg/m3) | NH3 (ppm) | CO (ppm) | | | | CO2 (ppm) | | | |
| 7AM-3PM | 3PM-11PM | 11PM-7AM | W\* | 7AM-3PM | 3PM-11PM | 11PM-7AM | W\* | W\* | W\* | 7AM-3PM | 3PM-11PM | 11PM-7AM | W\* | 7AM-3PM | 3PM-11PM | 11PM-7AM | W\* |
| Pit fans + recirculation  (ηdust = 0) | Recirculation ratio | 0 | 2 pit fans  Medium cold Wall insulation: 0.286 W/m2∙K Pit-air-exchange ratio: 0.1  Inhalable dust: 1.39 mg/s  Respirable dust: 0.14 mg/s | 2216 | 1.17 | 1.05 | 0.99 | 1.07 | 0.12 | 0.11 | 0.10 | 0.11 | 2.26 | 0.11 | 0.34 | 0.36 | 0.40 | 0.37 | 1524 | 1544 | 1628 | 1565 |
| 0.25 | 2122 | 1.29 | 1.16 | 1.09 | 1.18 | 0.13 | 0.12 | 0.11 | 0.12 | 2.49 | 0.12 | 0.34 | 0.35 | 0.43 | 0.37 | 1559 | 1586 | 1730 | 1625 |
| 0.50 | 1995 | 1.43 | 1.28 | 1.21 | 1.31 | 0.15 | 0.13 | 0.13 | 0.14 | 2.77 | 0.13 | 0.32 | 0.34 | 0.45 | 0.37 | 1583 | 1614 | 1825 | 1674 |
| 0.75 | 1828 | 1.62 | 1.45 | 1.36 | 1.47 | 0.17 | 0.15 | 0.14 | 0.15 | 3.12 | 0.15 | 0.30 | 0.32 | 0.43 | 0.35 | 1615 | 1645 | 1860 | 1707 |
| 1.00 | 1661 | 1.85 | 1.65 | 1.55 | 1.68 | 0.19 | 0.17 | 0.16 | 0.17 | 3.56 | 0.17 | 0.28 | 0.29 | 0.40 | 0.32 | 1656 | 1685 | 1902 | 1748 |
| Pit fans + recirculation + APC device | Filtration efficiency | 0.50 | 2 pit fans  Medium cold Wall insulation: 0.286 W/m2∙K Pit-air-exchange ratio: 0.1  Recirculation ratio: 0.75 Inhalable dust: 1.39 mg/s  Respirable dust: 0.14 mg/s | 1828 | 1.36 | 1.22 | 1.14 | 1.24 | 0.14 | 0.13 | 0.12 | 0.13 | 3.12 | 0.15 | 0.30 | 0.32 | 0.43 | 0.35 | 1615 | 1645 | 1860 | 1707 |
| 0.75 | 1828 | 1.26 | 1.13 | 1.06 | 1.15 | 0.13 | 0.12 | 0.11 | 0.12 | 3.12 | 0.15 | 0.30 | 0.32 | 0.43 | 0.35 | 1615 | 1645 | 1860 | 1707 |
| 1.00 | 1828 | 1.17 | 1.05 | 0.99 | 1.07 | 0.12 | 0.11 | 0.10 | 0.11 | 3.12 | 0.15 | 0.30 | 0.32 | 0.43 | 0.35 | 1615 | 1645 | 1860 | 1707 |
| Recirculation ratio | 25 | 2 pit fans  Medium cold Wall insulation: 0.286 W/m2∙K Pit-air-exchange ratio: 0.1 Filtration efficiency: 1 Inhalable dust: 1.39 mg/s  Respirable dust: 0.14 mg/s | 2122 | 1.17 | 1.05 | 0.99 | 1.07 | 0.12 | 0.11 | 0.10 | 0.11 | 2.49 | 0.12 | 0.34 | 0.35 | 0.43 | 0.37 | 1559 | 1586 | 1730 | 1625 |
| 50 | 1995 | 1.17 | 1.05 | 0.99 | 1.07 | 0.12 | 0.11 | 0.10 | 0.11 | 2.77 | 0.13 | 0.32 | 0.34 | 0.45 | 0.37 | 1583 | 1614 | 1825 | 1674 |
| 75 | 1828 | 1.17 | 1.05 | 0.99 | 1.07 | 0.12 | 0.11 | 0.10 | 0.11 | 3.12 | 0.15 | 0.30 | 0.32 | 0.43 | 0.35 | 1615 | 1645 | 1860 | 1707 |
| 100 | 1661 | 1.17 | 1.05 | 0.99 | 1.07 | 0.12 | 0.11 | 0.10 | 0.11 | 3.56 | 0.17 | 0.28 | 0.29 | 0.40 | 0.32 | 1656 | 1685 | 1902 | 1748 |
| Dust generation (mg/s)  Inhalable/Respirable dust | 0.69/0.07 | 2 pit fans  Medium cold Wall insulation: 0.286 W/m2∙K Pit-air-exchange ratio: 0.1  Filtration efficiency: 1Recirculation ratio: 0.75 | 1828 | 0.59 | 0.53 | 0.49 | 0.54 | 0.06 | 0.05 | 0.05 | 0.06 | 3.12 | 0.15 | 0.30 | 0.32 | 0.43 | 0.35 | 1615 | 1645 | 1860 | 1707 |
| 1.39/0.14 | 1828 | 1.17 | 1.05 | 0.99 | 1.07 | 0.12 | 0.11 | 0.10 | 0.11 | 3.12 | 0.15 | 0.30 | 0.32 | 0.43 | 0.35 | 1615 | 1645 | 1860 | 1707 |
| 2.77/0.29 | 1828 | 2.35 | 2.10 | 1.98 | 2.14 | 0.24 | 0.22 | 0.21 | 0.22 | 3.12 | 0.15 | 0.30 | 0.32 | 0.43 | 0.35 | 1615 | 1645 | 1860 | 1707 |