

Modelling of SO₂ and CO Pollution Due to Industry PLTD Emission Tello in Makassar Indonesia

¹Anwar Mallongi, ²Darwin Safiu, ²Hasnawati Amqam, ³Aminuddin Syam, ⁴Muhammad Hatta

⁵Tatik Sutarti, ⁶Muhib Abdul, ⁷Sandu Siyoto and ⁸Apollo

¹Department of Environmental Health,

²Department of Environmental Health, Faculty of Public Health,

³Public Health Nutrition,

⁴Department of Marine Science, Faculty of Fisheries and Marine,
University of Hasanuddin, Makassar, Indonesia

⁵STIKIP PGRI Pacitan, Pacitan, Indonesia

⁶Department of Nursing, STIKES Majapahit Mojokerto, Mojokerto, Indonesia

⁷Surya Mitra Husada Medical College of Kediri, East Java, Indonesia

⁸Foliteknik Negeri, Ujung Pandang, Makassar, Indonesia

Abstract: This study aims to determine the pattern of dissemination, distribution model and estimation of SO₂ and CO gas emission concentration derived from the Tello diesel engine with a dynamic model approach. The design of this research is descriptive quantitative with Gaussian Model approach and dynamic system model. The study was conducted at PLTD Tello Kota Makassar by collecting secondary data. For model distribution and estimation of SO₂ and CO pollution using Gaussian Model and dynamic modelling with Stella. Population in this research is data of emission parameters generated by Tello's steam power plant influenced by atmospheric stability, wind direction and velocity so as to obtain concentration of pollutant by using Gaussian calculation sample is SO₂ concentration and CO PLTD Tello contained in monitoring report on RKL&RPL implementation for 2012-2017. The results of the dominant area of research are the impact of pollution from the Tello diesel power plant based on the dominant wind direction during 2012-2016 is the Northwest part of the Tello steam power plant at a height of 1 m above the ground with a distance of 500, 1, 500, 2, 500 and 4,000 m of the Tello diesel powered TTL Aspol, Panaikang, Pampang and Rappokalling. Total SO₂ and CO emission concentrations derived from Tello PLTD during 2012-2016 in each location at 1 m above ground level with a distance of 500 m, i.e., Aspol Tello SO₂ 1.395 and CO 1.162 µg/m³ a distance of 1,500 m of SO₂ 1.247 and CO 1.039 µg/m³ 2,500 m distance of Pampang 0.878 µg/m³ and CO 0.7317 µg/m³ and a distance of 4,000 m of Rappokalling 0.6363 µg/m³ and CO 0.5303 µg/m³ from the pollutant source of the chimney PLTD Tello. The estimated concentration of Sulfur Dioxide (SO₂) and Carbon monoxide (CO) gas emissions based on 12 month dynamic model simulation (2018) is increasing every time until July 2018 at each of four location points at 1 m above the surface soil with a distance of 500 m of Aspol Tello SO₂ 0.26065 µg/m³ and CO 0.21530 µg/m³, 1500 m distance of Panaikang SO₂ 0.04447 µg/m³ and CO 0.03134 µg/m³, distance 2500 m of Pampang SO₂ 0.01760 µg/m³ and CO 0.00938 µg/m³ and a distance of 4,000 m of Rappokalling SO₂ 0.00740 µg/m³ and CO₂ 0.00611 µg/m³ from the source of the bursts of the Tello steam power plant with the rate of increase in the emission concentration of Asp2 SO₂ 0.0053 and CO 0.0044 times, SO₂ 0.0061 times and CO 0.0004 times, Pampang SO₂ 0.00021 times and CO 0.000073 times and Rappokalling SO₂ 0.000078 times and CO 0.000064 times every month. The concentration of SO₂ and CO emissions generated by the Tello steam power plant during 2012-2016 is still far below the ambient air quality standard (South Sulawesi Governor Decree No.69 Year 2010) in each location at a height of 1m above ground level, i.e., Aspol Tello 0-1.39 µg/m³, Panaikang 0-1.247 µg/m³, Pampang 0-0.878 µg/m³ and Rappokalling 0-0.6363 µg/m³. So, it can be said that the four areas are still included in the air quality is quite healthy.

Key words: Gaussian Model, model estimation, dynamics, SO₂, and CO pollution, TTL Aspol, quality.

Corresponding Author: Anwar Mallongi, Department of Environmental Health, Faculty of Public Health, University of Hasanuddin, Makassar, Indonesia

in air pollution, especially, SO₂ and CO parameters in the area around the PL TD Tello Makassar.

MATERIALS AND METHODS

Research sites: The research will be conducted at PLTD Tello which become the source of exhaust gas emission from the chimney produced by Tello PL TD production process. In increasing the electricity demand in Makassar and surrounding areas, the government in this case PLN build Steam Power Station as much as 2 units (2x12,500 MW) located in Tello. In 1971, it was operated and inaugurated by the president of the Republic of Indonesia Soeharto. To support the smooth supply of electricity in 1973 built 2 units of diesel engine with installed power (2x2.8 MW) located in the area of PLTU Tello. In June 1976 formed a Tello sector unit under the name PLN Region 8 Sector Tello with Bontoala and GI/Transmission Power Plant Units. In 1976, PLN Region 8 received an additional 1 unit Gas as Power Plant (PLTG) Weast can with installed power of 14.466 MW. In March of 2007, PLTD Kendari Unit and Bau-Bau Vehicle Unit separated from PLN Sector Tello and became its own sector, namely Kendari Sector. The change was re-made in November 2010, Selayar PLTD Unit which was originally a Unit of PLN Sector Bakaru joined Unit from PLN Sector Tello. In May 2012 PLTU Barru Unit which was originally PLN Unit Sector Bakaru joined PLN Unit Tello Sector. Year 2013, based on

Directors Decree No 570/KIDIR/2012 dated 30 November 2012, Tello Sector turned into Tello Generating Sector.

Design and variable research: This research is prognostic research (prognostic research), that is research which try to predict an air pollution event influenced by several factors that exist. This research method includes quantitative descriptive approach by designing a modelling form of CO₂ pollutant distribution SO₂ and CO using Gauss smoke assumption and dynamic system model approach i.e., data collection to design a model that aims to describe and predict future air pollution events around Tello diesel in Makassar City. The first stage in designing the model that is making wind flowers during the city of Makassar. The second stage in designing the model is to make the model flow diagram as follows (Fig. 1 and 2).

Population and sample: Population to be studied is the data of emission parameters generated by Tellos steam power plant influenced by atmospheric stability, wind direction and speed so as to obtain concentration of pollutant by using Gaussian calculation. SO₂ concentration of exhaust concentrate and CO PLTD Tello contained in monitoring report on RKL&RPL implementation 2012-2017.

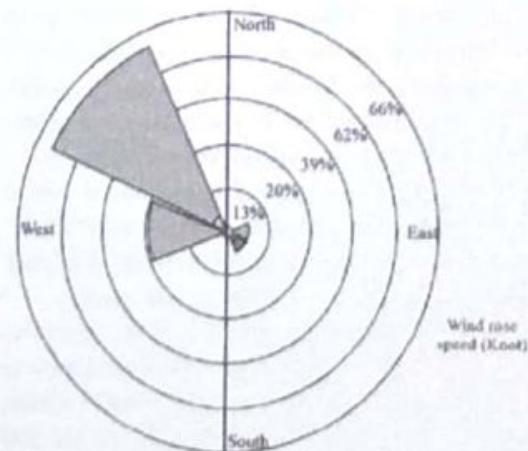


Fig. 1. Win rose in Makassar City year 2012-2016; Wind direction and speed

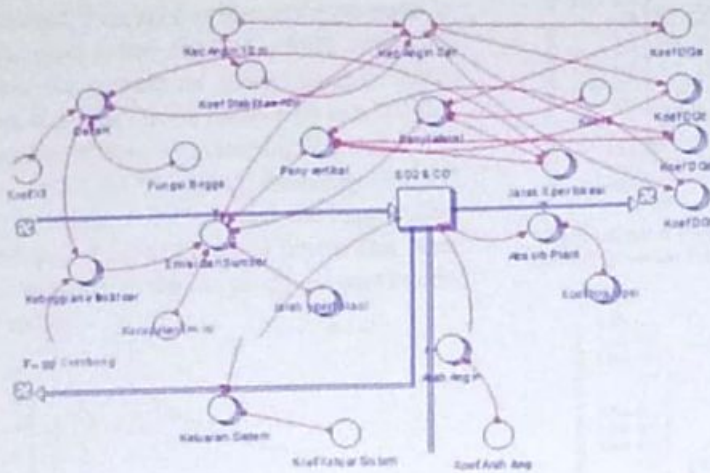


Fig. 2. Flow chart of SO₂ and CO₂ emission estimation model

Method of collecting data: The type of data collected in this study is secondary data. Secondary data consist of exhaust concentration obtained from PLTD Tello contained in monitoring report of RKL and RPL implementation year 2012-2017, data of wind speed, wind direction and sunlight obtained from B.tvIKG Makassar city.

Data analysis: This research is done through several stages of activity, both in the form of library research, data collection and processing as well as Gaussian Model analysis activities and estimation models using Stella 5.0

RESULTS AND DISCUSSION

The dominant area affected by pollution from the Tello diesel power plant based on the dominant wind direction during 2012-2016 is the Northwest Territory (NW) of the Tello steam power plant at a height of 1 m above ground level with a distance of 500, 1,500, 2,500 and 4,000 m of Tello's TTY powerhouses are Aspol Tello, Panaikang, Pampang and Rappokalling. Total SO₂ and CO emission concentrations derived from Tello PLTD during 2012-2016 in each location at 1 m above ground level with a distance of 500 m, i.e., Asp Tello SO₂ 1,395 µg/m³, CO 1.162 ug/m³, a distance of 1,500 m of SO₂ SO₂ 1.247 µg/m³ and CO 1,039 ug/m³, 2,500 m distance of Pampang SO₂ 0.878 µg/m³ and CO 0.7317

µg/m³ and a distance of 4,000 m, i.e., Rappokalling SO₂ 0.6363 µg/m³ and CO 0.5303 µg/m³ from source contaminant of Tello PLTD chimney (Fig. 3 and 4).

The estimated concentration of Sulfur Dioxide (SO₂) and Carbon Monoxide (CO) gas emissions based on 12 month dynamic model simulation (2018) is increasing every time until July 2018 at each of four location points at 1 m above the surface soil with a distance of 500 m of Aspol Tello SO₂ 0.26065 µg/m³ and CO 0.21530 µg/m³, 1,500 m distance of Panaikang SO₂ 0.04447 µg/m³ and CO 0.03134 µg/m³, distance 2500 m of Pampang SO₂ 0.01760 µg/m³ and CO 0.00938 µg/m³ and a distance of 4,000 m of Rappokalling SO₂ 0.00740 µg/m³ and CO 0.00611 µg/m³ from the source of the bursts of the Tello steam power plant with the rate of increase in the emission concentration of Asp2 SO₂ 0.0053 and CO 0.0044 times, Panaikang SO₂ 0.00061 times and CO 0.0004 times, Pampang SO₂ 0.00021 times and CO 0.000073 times and Rappokalling SO₂ 0.000078 times and CO 0.0000064 times every month (Fig. 5 and 6).

From the results of wind direction data processing, the wind direction is dominantly blowing is toward the Northwest (NW) of pollutant. Here is a picture of the impact area and the estimated depth of SO₂ and CO concentration of the Tello PLTD at each location.

From the data processing, it can be seen that the SO₂ and CO emission concentration generated by the Tello steam power plant during 2012-2016 is still far below the ambient air quality standard (South Sulawesi Governor Decree Number 69 year 2010) in each location at altitude 1 m above ground level, i.e., Aspero Tello 0-1.39 µg/m³, Panaikang 0-1.247 µg/m³, Pampang 0-0.878 µg/m³ and Rappokalling 0-0.6363 µg/m³ So, it can be said that the four areas are still included in the air quality is quite healthy (Fig. 7 and 8).

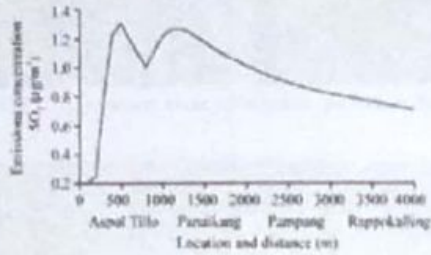


Fig.3. Total SO₂ T2 Emission power concentration based on distance from 2012-2016

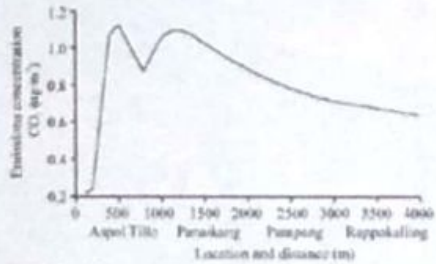


Fig.4. Total Emission concentration of CO PLTD Tello by distance year 2012-2016

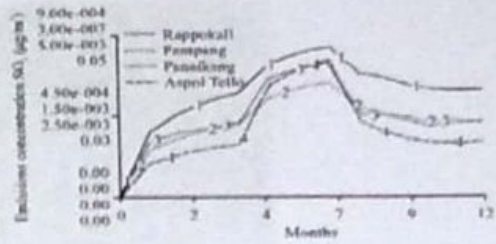


Fig.5. Estimated SO₂ emission concentration 12 months coming (2018) in four locations

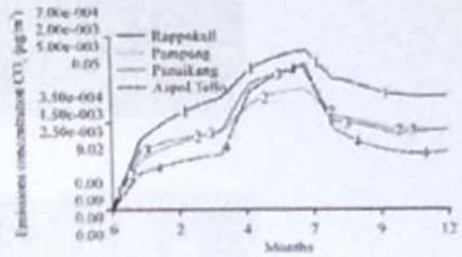


Fig.6. Estimated CO₂ 12 months emission concentration coming (2018) in four locations



Fig. 7: Dominant areas affected by pollution SO₂ and CO



Fig. 8: Estimated distribution and concentration of SO₂ and CO emissions in 4 sites

The SO₂ and CO emission concentration obtained from the calculations are influenced by the average emission load, wind speed and dominant wind direction and atmospheric stability over 5 years. The average wind speed during the last 5 years is 4 knots with the dominant wind direction to the Northwest (NW) then atmospheric stability ranges between unstable and slightly stable (A-C) conditions. Wind speeds that blow at a height of 10 m above ground level will affect the condition of atmospheric stability in the air. When wind speeds above 2 m/sec then the condition of atmospheric stability in the air will experience

instability. Conversely, when the wind speed below 2 m/sec then the condition of atmospheric stability in the air will experience stability.

The calculation result using Sreen View 3.5.0 Software obtained total SO₂ and CO emission concentration produced by Tello PLTD during 2012-2016 at height 1 m above ground level at each point location, i.e., Aspect Tello SO₂ 1.395 µg/m and CO 1.162 µg/m³, SO₂ 1.247 µg/m³ and CO 1.039 µg/m³, Pampang SO₂ 0.878 µg/m³ and CO 0.7317 µg/m³ and Rappokalling SO₂ 0.6363 µg/m³ and CO 0.5303 µg/m³.

The estimated concentration of Sulfur Dioxide (SO₂) and Carbon monoxide (CO) gas emissions based on 12 months dynamic model simulation (2018) is increasing every time until July 2018 at each of four location points at 1 m above the surface soil with a distance of 500 m of Aspol Tello SO₂ 0.26065 µg/m³ and CO 0.21530 µg/m³ 1.500 m distance of Panaikang SO₂ 0.04447 µg/m³ and CO 0.03134 µg/m³, distance 2500 m of Pampang SO₂ 0.01760 µg/m³ and CO 0.00938 µg/m³ and a distance of 4.000m of Rappokalling SO₂ 0.00740 µg/m³ and CO 0.00611 µg/m³ from the source of the bursts of the Tello steam power plant with the rate of increase in the emission concentration of Asp2 SO₂ 0.0053 and CO 0.0044 times, SO₂ 0.04061 times and CO 0.0004 times, Pampang SO₂ 0.00021 times and CO 0.000073 times and Rappokalling SO₂ 0.000078 times and CO 0.0000064 times every month.

Therefore, the higher the wind speed will make the condition of atmospheric stability in the air to be stable which causes SO₂ emissions and CO will be carried further away from the pollutant source of the Tello PLTD and the concentration of SO₂ emissions and CO will be spread to the air, thus, causing the SO₂ and CO emission concentration that is in the air will be lower. Conversely, when wind speed is lower it will make the condition of atmospheric stability in the air become unstable causing SO₂ and CO emissions will accumulate in the area around pollutant source that is Tello PLTD, causing SO₂ and CO emission concentration will be higher the area around Tello PLTD with distance 500-4,000 m at a height of 1 m above ground level.

Wind velocity affects the SO₂ and CO emission concentrations generated by the Tello PLTD. The greater the wind speed in the pollutant source area then the SO₂ and CO emission concentration in the Tello diesel field will be slightly reduced, if wind speed is smaller, then SO₂ and CO concentration will remain in the region. Another influence of wind speed, namely turbulence. Stronger winds cause frequent turbulence, so with turbulence, polluted air is mixed more quickly with air around the Tello power station and can resolve pollutant SO₂ and CO.

Unstable atmospheric conditions will disperse more pollutants in a vertical direction, so that, SO₂ and CO pollutants at maximum concentration will fall closer to the source of the Tello diesel bursts. So, the more stable the atmosphere will cause the decrease of SO₂ and CO emission concentration generated by Tello PLTD chimney as further SO₂ and CO pollutants fall at a certain distance with maximum emission concentration will be dispersed due to wind impulse. The temperature difference around the chimney with the temperature inside the Tello diesel plant will cause a different air pressure difference and the difference in air pressure will affect the SO₂ and CO emission speeds incurred by the Tello PLTD chimney.

SO₂ gas is a harmful contaminant for children, the elderly and people suffering from chronic respiratory illness and cardiovascular disease. Respiratory muscle can experience spasm when irritated by SO₂ and spasm will be more severe when SO₂ concentration is higher while air temperature is low. If the exposure time with SO gas is long enough there will be great inflammation of the mucous membrane followed by cilia paralysis (cilia becomes stiff/paralyzed), resulting in respiratory inflammation, shortness of breath and narrowing of the airway, damage to the epithelium layer, facilitate air pollution in and out of the respiratory tract both biological and chemical.

According to Fardiaz (1992), the relatively slow decomposition of COHb causes the inhibition of the molecular work of pigment cells in its function of carrying oxygen throughout the body. Conditions like this can be fatal because it can cause poisoning. Carbon monoxide (CO) gas poisoning can be characterized by mild conditions such as dizziness, headache and nausea. This condition can happen, so that, it can have an impact on the decreasing of public health condition that live around TTT PLTD region especially in the dominant area affected by the eruption of Aspol Tello, Panaikang, Pampang and Rappokalling. Moreover, the location in the Southwest (NW) PLTD Tello is on Jalan Urip Sumiharjo 7 km Makassar is a dense area of traffic which can increase the concentration of SO₂ emissions that are inhaled by the communities

surrounding the area (Russeng et al., 2018; Pulubuhu et al., 2018).

To reduce the concentration of SO₂ and CO emissions generated by the Tello PLTD can be done by installing a filter tool on the chimney that is scrubber. This tool serves to dissolve or absorb the gas pollutant into the liquid. The liquid granules still present in the post-washing gas stream should then

CONCLUSION

From the data processing, it can be seen that the SO₂ and CO emission concentration generated by Tello PLTD during 2012-2016 is still far below the ambient air quality standard (South Sulawesi Governor's Decree Number 69 Year 2010) in each location at 1 m altitude above ground level of Aspol Tello 0-1.39 µg/m³, Panaikang 0-1.247 µg/m³ Pampang 0-0.878 µg/m³ and Rappokalling 0-0.6363 µg/m³. So, it can be concluded that the four areas are still included in the air quality is quite healthy. The estimated concentration of Sulfur dioxide (SO₂) and Carbon monoxide (CO) gas emissions based on 12 months dynamic model simulation (2018) is increasing every time until July 2018 at each of four location points at 1 m above the surface soil with a distance of 500 m of Aspol Tello SO₂ 0.26065 µg/m³ and CO 0.21530 µg/m³, 1,500 m distance of Panaikang SO₂ 0.04447 µg/m³ and CO 0.03134 µg/m³ distance 2500 m of Pampang SO₂ 0.01760

be separated from the clean gas by another device called mist eliminator or entrainment separator. This tool can obtain high exhaust efficiency for particulate or gaseous pollutants, even in certain instances can obtain high exhaust efficiency for both pollutants (SO₂ and CO) in the same system (Khairumizan, 2008).

µg/m³ and CO 0.00938 µg/m³ and a distance of 4,000 m of Rappokalling SO₂ 0.00740 µg/m³ and CO 0.00611 µg/m³ from the source of the bursts of the Tello steam power plant with the rate of increase in the emission concentration of Asp2 SO₂ 0.0053 and CO 0.0044 times, SO₂ 0.04061 times and CO 0.0004 times, Pampang SO₂ 0.00021 times and CO 0.000073 times and Rappokalling SO₂ 0.000078 times and CO 0.0000064 times every month.

RECOMMENDATIONS

For local government and management of PLTD Tello it is necessary to review the condition of the feasibility of the location of the Tello power station located in the middle of the settlement. This should be done because emissions bursts that are released by PTLTD Tello each time can degrade the health of the people living around the Tello power plant from time to time.

REFERENCES

- Aji, B.S., 2006. [Mapping pollutant distribution as material for consideration of green open space development (RTH) in Cilegon City]. Master Thesis, Department of Rights of Vasi Sumbe Rdaya H Utan to N Eko Wisat., Agriculture Institute Bogor, Indonesia.
- AlRafea, K., A Elkamel and S.A. Abdul-Wahab, 2016. Cost-analysis of health impacts associated with emissions from combined cycle power plant. *J. Cleaner Prod.*, 139: 1408-1424.
- Fardiaz, S., 1992. [Water and Air Pollution]. Kanisius Publisher, Yogyakarta, Java, Indonesia, ISBN-979-413-770-7, Pages: 193 (In Indonesian).
- Gehrsitz, M., 2017. The effect of emission zones on air pollution and infant health. *J. Environ. Econ. Manage.*, 83: 121-144.
- Hosseiniabalam, F. and O. Ghaffarpasand, 2015. The effects of emission sources and meteorological factors on Sulphur dioxide concentration of Great Isfahan, Iran. *Atmos. Environ.*, 100: 94-101.
- Islam, S.M.N., P.L. Jackson and J. Aherne, 2016. Ambient Nitrogen dioxide and sulfur dioxide concentrations over a region of natural gas production, Northeastern British Columbia, Canada. *Atmos. Environ.*, 143: 139-151.
- Khairunnizan, P., 2008. [Experimental study of the implementation of venturi scrubber in coal gasification systems]. Master Thesis, University of Indonesia Library, Depok, Indonesia. (In Indonesian).
- Mukono, 2011. [Air Pollution and its Effects on Respiratory Chains]. Pusat Penerbitan Dan percetakan Universitas Airlangga, Surabaya, Indonesia. (In Indonesian).
- Pulubuhu, D.A.T., K. Evans, M. Arsyad and A Mallongi, 2018. Understanding the perspectives of village leaders and institutions in transforming social conflict into peace and health. *Indian J. Public Health Res. Dev.*, 9: 314-318.
- Russeng, S.S., L.M. Saleh, D. Virani, A.W.L. Latief and A Mallongi, 2018. The investigation of the lactic acid change among employee of national electrical power plan. *Indian J. Public Health Res. Dev.*, 9: 361-365.
- Sakti, E.S., 2012. [Overview of ambient air quality (NO₂, SO₂, total suspended particulate) against ARI events in Bekasi City 2004-2011]. MSc Thesis, University of Indonesia, Depok, Indonesia. (In Indonesian).
- Sastrawijaya, AT., 1991. [Environmental Pollution]. Rineka Cipta, Jakarta, Indonesia, ISBN 9789795182092, Pages: 274 (In Indonesian).
- Ul-Haq, Z., S. Tariq and M. Ali, 2016. Anthropogenic emissions and space-borne observations of carbon monoxide over South Asia. *Adv. Space Res.*, 58: 1610-1626.
- Yan, D., Y. Lei, L. Li and W. Song, 2017. Carbon emission efficiency and spatial clustering analyses in China's thermal power industry: Evidence from the provincial level. *J. Cleaner Prod.*, 156: 518-527.

MODELLING_Journal_of_Engineering_and_Applied_Sciences_1.

ORIGINALITY REPORT

%0

SIMILARITY INDEX

%0

INTERNET SOURCES

%0

PUBLICATIONS

%0

STUDENT PAPERS

PRIMARY SOURCES

1

I.S. Walker, T.W. Forest. "Field measurements of ventilation rates in attics", Building and Environment, 1995

Publication

<%1

EXCLUDE QUOTES ON

EXCLUDE BIBLIOGRAPHY ON

EXCLUDE MATCHES < 5 WORDS