Joint Crediting Mechanism Approved Methodology ID_AM024
“Replacement of diffuser with aerator in aeration pond”

A. Title of the methodology

Replacement of diffuser with aerator in aeration pond, Version 01.0

B. Terms and definitions

Terms	Definitions
Diffuser	Aeration device in the shape of a disc, tube or plate, which is used to supply air from blowers into wastewater for aerobic wastewater treatment by producing fine bubbles in aeration ponds for wastewater treatment.
Aerator	Aeration device without power unit, which is used to supply air from blowers into wastewater for aerobic wastewater treatment by mixing air and wastewater in itself and producing water circulation in the entire aeration ponds.

C. Summary of the methodology

Items	Summary
GHG emission reduction measures	For aerobic wastewater treatment, aeration device(s) is(are) used for supplying air into wastewater. Replacement of the diffuser with the aerator enables to reduce air discharge pressure at blower(s), to run blower(s) not continuously but intermittently and to reduce discharge amounts of air from blower(s). By these effects, electricity consumption at blower(s) can be reduced.
Calculation of reference emissions	Reference emissions are calculated with electricity consumption of blower(s) connected with project aeration devices of aerator (hereinafter referred to as “project blower(s)”), ratio of operating time of blower(s) connected with reference aeration devices of diffuser (hereinafter referred to as “reference

	blower(s)") and project blower(s), ratio of shaft power of reference/project blower(s), and CO_2 emission factor for consumed electricity.
Calculation of project emissions	Project emissions are calculated with electricity consumption of project blower(s) and CO_2 emission factor for consumed electricity.
Monitoring parameters	· Electricity consumption at project blower(s) · Operating time of project blower(s) · Stop time of project blower(s) during intermittent operation · Discharge pressure of project blower(s) · Rotations per minute of project blower(s)

D. Eligibility criteria

This methodology is applicable to projects that satisfy all of the following criteria.

Criterion 1	Aerator(s) is(are) installed to replace existing diffuser(s) in existing aeration pond(s) for wastewater treatment.
Criterion 2	Effluent wastewater quality meets the wastewater quality standards on items such as biochemical oxygen demand (BOD), chemical oxygen demand (COD) and total suspended solids (TSS) which are applicable to the project site.

E. Emission Sources and GHG types

Reference emissions	
Emission sources	GHG types
Electricity consumption by blower(s) which supply air to diffuser(s)	CO_2
Project emissions	
Emission sources	GHG types
Electricity consumption by blower(s) which supply air to aerator(s)	CO_2

F. Establishment and calculation of reference emissions

F.1. Establishment of reference emissions

The shaft power of reference blower(s) and project blower(s) is conservatively set in the

following manner to conservatively calculate reference emissions and ensure the net emission reductions.

1. The estimated shaft power of the reference blower *i* during the period *p* ($SP_{RE,i,p}$) is selected from the performance table of the blower *i* with the calculated daily discharge pressure of the reference blower *i* during the period *p* ($PS_{RE,i,p}$) and the calculated rotations per minute (RPM) of the reference blower *i* during the period *p* ($RPM_{RE,i,p}$). The performance table of the blower *i* is provided by manufacturer of the blower *i*.

$$SP_{RE,i,p} = f_{RE}\left(PS_{RE,i,p}, RPM_{RE,i,p}\right)$$

$SP_{RE,i,p}$	:	Estimated shaft power of the reference blower *i* during the period *p* [kW]
$PS_{RE,i,p}$	:	Calculated daily discharge pressure of the reference blower *i* during the period *p* [Pa (G)] (gauge pressure, and so forth)
$RPM_{RE,i,p}$	:	Calculated RPM of the reference blower *i* during the period *p* [rpm]

2. $PS_{RE,i,p}$ is calculated by the average daily discharge pressure of the project blower *i* monitored once a day during the period *p* ($PS_{PJ,ave,i,p}$) divided by the ratio of discharge pressure change at the blower *i* ($F_{PS,i}$). $F_{PS,i}$ is calculated by the highest daily discharge pressure of the project blower *i* monitored once a day during the parameter monitoring period *intpj* which start after completion of aerator installation ($PS_{PJ,high,i,intpj}$) divided by the lowest daily discharge pressure of the reference blower *i* monitored once a day during the parameter monitoring period *intre* before the aerator installation ($PS_{RE,low,i,intre}$).

$$PS_{RE,i,p} = PS_{PJ,ave,i,p} \div F_{PS,i}$$
$$F_{PS,i} = PS_{PJ,high,i,intpj} \div PS_{RE,low,i,intre}$$

$PS_{PJ,ave,i,p}$	:	Average daily discharge pressure of the project blower *i* during the period *p* [Pa (G)]
$F_{PS,i}$	:	Ratio of discharge pressure change at the blower *i* [-]
$PS_{PJ,high,i,intpj}$	:	Highest daily discharge pressure of the project blower *i* during the parameter monitoring period after completion of aerator installation [Pa (G)]
$PS_{RE,low,i,intre}$	:	Lowest daily discharge pressure of the reference blower *i* during the parameter monitoring period before the aerator installation [Pa (G)]

If the project blower *i* is replaced at the time $T_{p,change}$ during the period *p*, emission reductions during the time $T_{p,start}$, which is the start time of the period p, and $T_{p,change}$ are calculated with $PS_{PJ,ave,i,p}$ which is monitored from $T_{p,start}$ to $T_{p,change}$. Emission reductions after $T_{p,change}$ are calculated based on $PS_{PJ,ave,i,p}$ which is monitored after $T_{p,change}$ to the end time of the period p ($T_{p,end}$).

3. $RPM_{RE,i,p}$ is calculated from the average RPM of the project blower i during the period p ($RPM_{PJ,ave,i,p}$) divided by the ratio of RPM change at the blower i ($F_{RPM,i}$). $F_{RPM,i}$ means the ratio of RPM change from the reference blower i to the project blower i at completion of aerator installation and is provided by the manufacturer of pulley because RPM is associated with specification of pulley. $RPM_{PJ,ave,i,p}$ is monitored by rotation speed meter once a day during the period p.

$$RPM_{RE,i,p} = RPM_{PJ,ave,i,p} \div F_{RPM,i}$$

$F_{RPM,i}$	:	Ratio of RPM change at the blower i [-]
$RPM_{PJ,ave,i,p}$	:	Average RPM of the project blower i during the period p [rpm]

4. The estimated shaft power of the project blower i during the period p ($SP_{PJ,i,p}$) is selected from the performance table of the blower i with the $PS_{PJ,ave,i,p}$ and $RPM_{PJ,ave,i,p}$.

$$SP_{PJ,i,p} = f_{PJ}\left(PS_{PJ,ave,i,p}, RPM_{PJ,ave,i,p}\right)$$

$SP_{PJ,i,p}$	:	Estimated shaft power of the project blower i during the period p [kW]

Note 1: The performance table of the blower i shows relationship among discharge pressure [Pa (G)], RPM [rpm] and shaft power [kW] of the blower i in tabular format.

Note 2: Default value of the parameter monitoring period is 1 week excluding exceptional operation. The value of RPM of the blower i and depth of aeration pond(s) during the parameter monitoring period need to be the same as the value monitored before the installation of aerator. Monitored discharge pressure or RPM data on exceptional operation, such as during maintenance of blower, black out, accident of blower or aeration device etc., are excluded from data set for determining $PS_{PJ,ave,i,p}$, $PS_{PJ,high,i,intpj}$, $PS_{RE,low,i,intre}$, *and* $RPM_{PJ,ave,i,p}$.

F.2. Calculation of reference emissions

The electricity consumption of the reference blower i during the period p ($EC_{RE,i,p}$) is calculated by the product of $SP_{RE,i,p}$, the motor efficiency of the reference blower i (H_i) and $OT_{RE,i,p}$. Since H_i is common to the project blower i, reference emissions are calculated by following equation.

$$RE_p = \sum_i \left\{ \frac{OT_{RE,i,p}}{OT_{PJ,i,p}} \times \frac{SP_{RE,i,p}}{SP_{PJ,i,p}} \times EC_{PJ,i,p} \times EF_{elec} \right\}$$

RE_p	:	Reference emissions during the period p [tCO_2/p]
$OT_{RE,i,p}$	:	Operating time of the reference blower i during the period p [h/p]
$OT_{PJ,i,p}$	:	Operating time of the project blower i during the period p [h/p]
$SP_{RE,i,p}$	:	Estimated shaft power of the reference blower i during the period p [kW]
$SP_{PJ,i,p}$	:	Estimated shaft power of the project blower i during the period p [kW]
$EC_{PJ,i,p}$	:	Electricity consumption of the project blower i during the period p [kWh/p]
EF_{elec}	:	CO_2 emission factor for consumed electricity [tCO_2/kWh]

$OT_{RE,i,p}$ is calculated from $OT_{PJ,i,p}$ added by the stop time of the project blower i during intermittent operation during the period p ($IT_{PJ,i,p}$) since the reference blower(s) is(are) not allowed to run intermittently and needs to be run continuously for preventing clogging of pores in diffuser.

$$OT_{RE,i,p} = OT_{PJ,i,p} + IT_{PJ,i,p}$$

$IT_{PJ,i,p}$	:	Stop time of the project blower i during intermittent operation during the period p [h/p]

G. Calculation of project emissions

Project emissions are calculated by following equation.

$$PE_p = \sum_i \left(EC_{PJ,i,p} \times EF_{elec} \right)$$

PE_p	:	Project emissions during the period *p* [tCO_2/p]
$EC_{PJ,i,p}$	:	Electricity consumption of project blower *i* during the period *p* [kWh/p]
EF_{elec}	:	CO_2 emission factor for consumed electricity [tCO_2/kWh]

H. Calculation of emissions reductions

Emission reductions are calculated as the difference between the reference emissions and project emissions, as follows:

$$ER_p = RE_p - PE_p$$

ER_p	:	Emissions reductions during the period p [tCO_2/p]
RE_p	:	Reference emissions during the period *p* [tCO_2/p]
PE_p	:	Project emissions during the period *p* [tCO_2/p]

I. Data and parameters fixed *ex ante*

The source of each data and parameter fixed *ex ante* is listed as below.

Parameter	Description of data	Source
EF_{elec}	CO_2 emission factor for consumed electricity. When project blower consumes only grid electricity or captive electricity, the project participant applies the CO_2 emission factor respectively. When project blower may consume both grid electricity and captive electricity, the project participant applies the CO_2 emission factor with lower value. [CO_2 emission factor] For grid electricity: The most recent value available from the source stated in this table at	[Grid electricity] The data is sourced from “Emission Factors of Electricity Interconnection Systems”, National Committee on Clean Development Mechanism (Indonesian DNA for CDM), based on data obtained by Directorate General of Electricity, Ministry of Energy and Mineral Resources, Indonesia, unless otherwise instructed by the Joint Committee. [Captive electricity]

	the time of validation For captive electricity, it is determined based on the following options: a) Calculated from its power generation efficiency (η_{elec} [%]) obtained from manufacturer's specification The power generation efficiency based on lower heating value (LHV) of the captive power generation system from the manufacturer's specification is applied; $EF_{elec} = 3.6 \times \frac{100}{\eta_{elec}} \times EF_{fuel}$ b) Calculated from measured data The power generation efficiency calculated from monitored data of the amount of fuel input for power generation ($FC_{PJ,p}$) and the amount of electricity generated ($EG_{PJ,p}$) during the monitoring period p is applied. The measurement is conducted with the monitoring equipment to which calibration certificate is issued by an entity accredited under national/international standards; $EF_{elec} = FC_{PJ,p} \times NCV_{fuel} \times EF_{fuel} \times \frac{1}{EG_{PJ,p}}$ Where: NCV_{fuel} : Net calorific value of consumed fuel [GJ/mass or volume] Note: In case the captive electricity generation system meets all of the following conditions, the value in the following table may be applied to EF_{elec} depending on the consumed	For the option a) Specification of the captive power generation system provided by the manufacturer (η_{elec} [%]). CO_2 emission factor of the fossil fuel type used in the captive power generation system (EF_{fuel} [tCO_2/GJ]) For the option b) Generated and supplied electricity by the captive power generation system ($EG_{PJ,p}$ [MWh/p]). Fuel amount consumed by the captive power generation system ($FC_{PJ,p}$ [mass or volume/p]). Net calorific value (NCV_{fuel} [GJ/mass or volume]) and CO_2 emission factor of the fuel (EF_{fuel} [tCO_2/GJ]) in order of preference: 1) values provided by the fuel supplier; 2) measurement by the project participants; 3) regional or national default values; 4) IPCC default values provided in tables 1.2 and 1.4 of Ch.1 Vol.2 of 2006 IPCC Guidelines on National GHG Inventories. Lower value is applied.

<table>
<tr>
<td></td>
<td>fuel type.

• The system is non-renewable generation system
• Electricity generation capacity of the system is less than or equal to 15 MW

<table>
<tr><td>fuel type</td><td>Diesel fuel</td><td>Natural gas</td></tr>
<tr><td>EF_{elec}</td><td>0.8 *1</td><td>0.46 *2</td></tr>
</table>

*1 The most recent value at the time of validation is applied.
*2 The value is calculated with the equation in the option a) above. The lower value of default effective CO_2 emission factor for natural gas (0.0543tCO_2/GJ), and the most efficient value of default efficiency for off-grid gas turbine systems (42%) are applied.</td>
<td>[Captive electricity with diesel fuel]
CDM approved small scale methodology: AMS-I.A.

[Captive electricity with natural gas]
2006 IPCC Guidelines on National GHG Inventories for the source of EF of natural gas.
CDM Methodological tool "Determining the baseline efficiency of thermal or electric energy generation systems version02.0" for the default efficiency for off-grid power plants.</td>
</tr>
<tr>
<td>$PS_{RE,low,i,intre}$</td>
<td>Lowest daily discharge pressure of the reference blower i during the parameter monitoring period intre before the aerator installation [Pa (G)]

$PS_{RE,low,i,intre}$ is selected from the daily data which is monitored once a day during the parameter monitoring period before the aerator installation.</td>
<td>Discharge pressure is monitored by pressure gauge installed at discharge air pipe of the blower i. $PS_{RE,low,i,intre}$ needs to be monitored before the aerator installation.</td>
</tr>
<tr>
<td>$PS_{PJ,high,i,intpj}$</td>
<td>Highest daily discharge pressure of the project blower i during the parameter monitoring period intpj after completion of aerator installation [Pa (G)]

$PS_{PJ,high,i,intpj}$ is selected from the daily data which is monitored once a day during the parameter monitoring period which start after</td>
<td>Discharge pressure is measured by pressure gauge installed at discharge air pipe of the blower i. $PS_{PJ,high,i,intpj}$ needs to be monitored just after completion of aerator installation.</td>
</tr>
</table>

	completion of aerator installation.	
$F_{PS,i}$	Ratio of discharge pressure change at the blower *i* [-]	$F_{PS,i}$ is calculated by $PS_{PJ,high,i,intpj}$ divided by $PS_{RE,low,i,intre}$.
$F_{RPM,i}$	Ratio of RPM change at the blower *i* [-]	$F_{RPM,i}$ is provided by the manufacturer of pulley or calculated from the diameter of pulleys of the project/reference blower *i*.

History of the document

Version	Date	Contents revised
01.0	17 September 2020	Electronic decision by the Joint Committee Initial approval.