Ø ZDHC

ZDHC Man-Made Cellulosic Fibres (MMCF) Guidelines

Version 1.0

April 2020

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Revision history

Version Number	Changes	Time of publication
Version 1.0	Initial publication of the ZDHC Man-Made Cellulosic Fibres Production Wastewater Guidelines	2020

Related Work

This document is one part of a series of solutions provided by ZDHC. Manufacturing facilities are expected to comply with the solutions applicable to them, considering the type of processes conducted in their facility. For that the following documents must be taken into account:

ZDHC MMCF Guidelines – The three guidelines are related among each other.

ZDHC MMCF Interim Wastewater Guidelines

ZDHC Wastewater Guidelines

ZDHC Wastewater and Sludge Laboratory Sampling and Analysis Plan (SAP)

ZDHC MMCF Interim Air Emissions Guidelines

ZDHC Air Emission Guidelines - under development

Chemical Inventory List (CIL)

ZDHC MMCF Responsible Fibre Production Guidelines

ZDHC Wastewater Guidelines

ZDHC Air Emissions Guidelines - under development

ZDHC CMS - Framework (Coming in Q2 2020)

Chemical Inventory List (CIL)

Definitions

To help understanding the implementation of our documents the following definitions will be used to indicate requirements, recommendations, permissions and/or possibilities:

- Shall: Used to indicate a requirement.
- Should: Used to indicate a recommendation.
- May: Used to indicate permission.
- Can: Used to indicate possibility or capability.

For more definitions please click here.

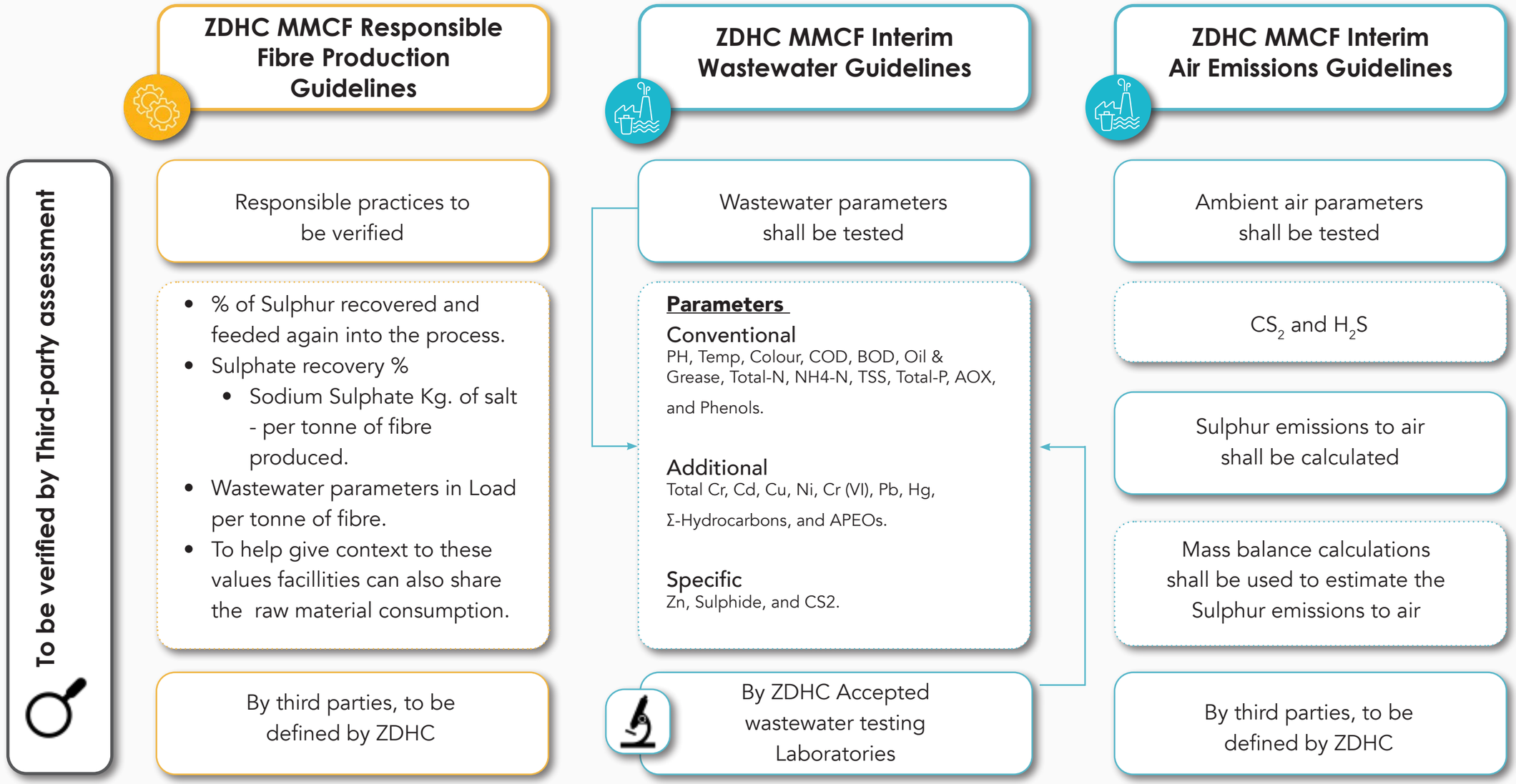
Abbreviations

CETP	Centralised EffluentTreatment Plant
CIL	Chemical Inventory List
CMS	Chemical Management System
Cupro	Cuprammonium rayon
EN	European Norm
ETP	Effluent Treatment Plant
EU BAT BREF POL	EU-BAT BREF Reference Document on Best Available Techniques in the Production of Polymers (August 2007)
GB	Guojia Biaozhun (Chinese required national standard)
GB/T	Guojia Biaozhun/Tuījiàn, (Chinese recommended national stadard)
HJ/T	Chinese recommended environmental protection standard (Chinese industry standard)
IPE	Institute of Public & Environmental Affairs - Chinese Non-Governmental Organization
ISO	International Organization for Standardization
LC	Liquid Chromatography
MMCF	Man-Made Cellulosic Fibres
MRSL	Manufacturing Restricted Substances List
N/A	Not Available or Not Applicable
PTE	Potential to Emit
RL	Reporting Limit
USEPA	United States Environmental Protection Agency
WHO	World Health Organization
WWTP	Wastewater Treatment Plant

Summary

In the last years MMCF has become an increasingly important fibre category, stimulated by the growing number of brands that have committed to use of preferred fibres[a]. With its production volume doubled in past decades it is expected to continue its market growth due to MMCF's sustainable potential. The ZDHC Roadmap to Zero Programme (ZDHC) recognises the value of addressing hazardous substances that may be discharged into the environment, generated across the value chain of the textile and footwear industry, and decided to address MMCF production process by collaboratively creating an aligned approach for manufacturing facilities by working towards a circular approach for the substances present in the process and to generate cleaner outputs from production.

As a multi-stakeholder initiative working towards a common goal, ZDHC understands that achieving it requires collaborative efforts in the industry. The ZDHC MMCF Guidelines is a set of guidelines that addresses integrated expectations for discharge wastewater quality, emissions to air, and chemical recovery for manufacturing facilities producing Man-Made Cellulosic Fibres.



[a] Textile Exchange – Preferred Fibre & Materials.

Contents

Introduction

The ZDHC Roadmap to Zero Programme (ZDHC) is a collaboration of brands, value chain affiliates and associates committed to eliminating hazardous substances from the textile, apparel and footwear value chain. ZDHC recognises that achieving this goal requires collaborative efforts in the industry, especially in regard to capacity building, time, technology, and innovation.

The ZDHC Programme recognises the value of addressing hazardous substances that may be discharged into the environment during the manufacture of materials used in the textile and footwear industry. That is hazardous substances, which could be used deep within the value chain and not just those substances that could be present in finished goods. Discharge of wastewater or air emissions containing hazardous substances could have a significant impact on the environment.

Background

In January 2018 ZDHC commissioned an expert report on the production of Man-Made Cellulosic Fibres (MMCF). The report concluded that due to technical limitations, the inclusion to the ZDHC MRSL of the chemical substance Carbon disulphide (CS_2) (used as a solvent for the production of Viscose and Modal) was not feasible - because a restriction of this chemical would halt the Viscose and Modal production processes. The conclusion was that the ZDHC Roadmap to Zero Programme could have substantial impact by collaboratively setting guidance around good chemical management. Alongside setting guidance limits for wastewater, sludge, air emissions and chemical recovery during fibre production while calling for continued further research into processes for the production of MMCF, using alternative and less hazardous substances.

Objective

ZDHC MMCF Guidelines

During the last years MMCF has become an increasingly important fibre category, incentivised by the growing number of brands committed to the use of preferred fibres[a]. With its production volume doubled in past decades it is expected to continue its market growth due to MMCF's sustainable potential. For this reason, ZDHC decided to address its production process by collaboratively creating an aligned approach for manufacturing facilities to generate cleaner outputs from production while including a circular approach to its process.

The ZDHC MMCF Guidelines is a set of guidelines that addresses integrated expectations for discharge wastewater quality, emissions to air, and chemical recovery for manufacturing facilities producing Man-Made Cellulosic Fibres.
The complete set includes:

- ZDHC MMCF Responsible Fibre Production Guidelines
- ZDHC MMCF Interim Wastewater Guidelines
- ZDHC MMCF Interim Air Emissions Guidelines

The ZDHC MMCF Guidelines should be implemented as one, as the outputs from the production process of fibres cannot be seen as separate. These three documents provide guidance for an aligned industry approach. With this set of documents, ZDHC appeals to its members and the entire industry to improve the quality of discharged industrial wastewater and production-related emissions to air. With this, ZDHC expects also to support the transition of the production of MMCF towards a circular approach, by proposing recovery rates for substances such as Sulphur compounds.

ZDHC aims to catalyse a roadmap to define milestones for fibre manufacturing facilities to advance towards the production described in EU BAT BREF Reference Document on Best Available Techniques for the Production of Polymers (EU BAT BREF POL). Aiming to achieve integrated prevention and control of pollution arising from the production, leading to a high level of environmental protection[i] (EUROPEAN COMMISSION - IPPC Bureau 2007).

[a] Textile exchange – Preferred Fibre & Materials.

The scope expansion plan of this document includes the outputs proceeding from the dissolving pulp[a] for MMCF fibres, and other fibres including but not limited to:

- Viscose Filament Yarn[a]
- Modal Filament Yarn[a]
- Lyocell[a]
- Cupro
- Acetate
- Triacetate
- Fibres based on next generation feedstock

In this document a three-level approach is proposed:

- As manufacturing facilities are not identical in terms of capabilities, knowledge, strategic priorities or resources, this document provides a three-level (foundational, progressive, aspirational) approach for the limit values and/or recovery rates of the proposed parameters.
- Manufacturing facilities shall proactively develop and manage a data-driven, continuous improvement plan to reach the next level. To create this continuous improvement plan, ZDHC MMCF Implementation Guidelines should be observed.

Levels defined:

- **Foundational**: First level to be achieved by manufacturing facilities at minimum.
- **Progressive**[b]: AAn intermediate level to be achieved by manufacturing facilities through the application of technologies such as, but not limited to, those mentioned in the Reference Document: EU-BAT BREF Reference Document on Best Available Techniques in the Production of Polymers, (EU BAT BREF POL) corresponding to the viscose production processes.
- **Aspirational**: To become best in class, manufacturing facilities shall achieve the third level, through the application of technologies such as, but not limited to, those mentioned in the Reference Document: EU-BAT BREF Reference Document on Best Available Techniques in the Production of Polymers (EU BAT BREF POL) applicable to viscose and beyond. This achievement sits alongside the supplier further enhancing their chemical management.

To learn more about the continuous improvement roadmap, see ZDHC MMCF Guidelines Implementation Plan.

[a] The work in order to add these fibres/process to the scope of this document will start in June 2020, and the publication date is yet to be defined,

[b] Approximately 43% of the global production market have active commitments of reaching this level by 2023-2025.

Chapter 1: ZDHC MMCF Responsible Fibre Production Guidelines

The objective of this guideline is to address the expectations for process chemical recovery rates, as well as provide additional recommendations for best practices in production of Man-Made Cellulosic Fibres.

1. Scope

The feedstock in-scope for the production of the below mentioned fibres includes but is not limited to, wood and bamboo.

The fibres within the scope of this document are:

- Viscose Staple Fibres
- Modal Staple Fibres

2. Best practices for fibre feedstock

The selection of the feedstock for the production of MMCF can have great impact on the environment. The increasing growth of the market share of these fibres, shows a need to establish clear policies related to raw material input. The following sub-sections are some recommended best practices that should be implemented by your organisation.

2.1. Raw material sourcing

a. Your organisation should have a responsible raw material policy defining the sourcing of wood, pulp, and/or pulp fibre; eliminating the sourcing from ancient and endangered forests, endangered species habitats and controversial sources. To support this policy, your organisation should:
   i. Take part in the CanopyStyle verification audits in order to assess the sourcing of raw materials.
   ii. Complete verification audits in order to assess the sourcing of raw materials.
   iii. Can include a requirement for the raw materials to be certified by sustainable forestry standard. Certification bodies that examine each individual forest are preferred.

b. In order to ensure transparency throughout the value chain, your organisation should have a proper chain of custody system, which includes but is not limited to blockchain-based traceability or use of Unique Trace.

2.2. Circularity and recycled feedstock

In order to reduce the environmental impact of the MMCF production it is imperative to incentivise new developments that lead to the creation of a product fitted for purpose within a circular economy.

For this reason, Brands and Manufacturing facilities should work to reduce the input of virgin raw materials by increasing the amount of alternative fibre feedstock, included but not limited to pre and post-consumer fibre waste and agricultural waste.

a. Your organisation should have a sourcing strategy that includes commitments to increase the percentage of raw material originated from next generation[a] feedstock, with clearly defined feedstock, targets and timelines for adopting materials originated, from next generation feedstock.

[a] ZDHC refers to Next Generation feedstock as the one originated from alternative and recycled feedstock.

3. Responsible production of viscose and modal staple fibres

Another aspect to consider when planning to move to a circular economy approach, is the recovery of chemicals used or produced as a by-product during the fibre production process.

Manufacturing facilities should strive for continuous improvement in the management of hazardous substances within their value chain. For this reason, the policies around the production of these fibres should include alternative non-virgin feedstock sources and also address the recovery of chemicals and by-products related to the MMCF production process.

3.1. Chemical Recovery

During the production process of Viscose and Modal (staple fibres), Sulphur compounds from the spin bath and Sodium Sulphate as by product should be recovered and either returned to on-site production processes or sold as by-product. In order for these substances (Sulphur and Sodium Sulphate) to reach the recovery percentage in this document, control technologies and recovery treatments should be applied.

3.1.1. Sulphur recovery

Treatments methods and control technologies

The Sulphur recovery treatment methods mainly include:

- CS_2 recovery from Spinning off-gases by Condensation Route.
- CS_2 recovery by activated carbon adsorption from exhaust gases of spinning & spin bath, coupled with either of following upstream process to remove H_2S:
  a) Recovery as Sulphur by Catalytic Redox Process.
  b) Recovery as $NaHS+Na_2S$ produced by caustic scrubbing.
- Conversion of both CS_2 & H_2S to Sulphuric Acid by a catalytic process.

There are various Sulfur recovery technologies available within the viscose and modal production. The control technology applied at the point of fibre production depends on many conditions, including:

- Year of establishment of the plant and the technology used
- National regulations
- Best Available Technologies

Recovery rates

Correlation of Sulphur release to Air and the corresponding Sulphur recovery rates in percentage of CS_2 charged in feed.

Table 1 - Sulphur recovery rates

ZDHC levels	Total Sulphur to Air[a] (Kg/Tonne Fibre)	Corresponding Sulphur recovery in % of CS_2 added in the process
Foundational	35	85%
Progressive	20	92%
Aspirational	12	95%[b]

3.1.2. Sulphate recovery

This document recognises there are several technologies available for the recovery of Sulphate during the MMCF production process. It is important to clarify that while this document focuses on the recovery of Sodium Sulphate salt, there are other recovery technologies available. It is the intention of ZDHC to review technologies available in the market and add to the revisions of this document.

[a] Limits from ZDHC MMCF Air Emissions Guidelines

[b] Conversion is based on the ZDHC MMCF Air emissions guidelines Sulphur to air parameter combined with the industrial average of carbon disulfide consumption addition of 280 kg/tonne of fibre.

For those manufacturing facilities recovering Sulphate using any other recovery technologies, the following recovery rates should apply:

ZDHC levels	Unit	Sulphate recovery
Foundational	%	50
Progressive		60
Aspirational		70

3.1.2.1. Sodium Sulphate recovery rates[a]

Table 2 - Sodium Sulphate recovery rates

	Sodium Sulphate recovery - Kg of salt per Tonne of Fibre produced
Foundational	500
Progressive	600
Aspirational	700

Calculation of Sodium Sulphate Recovery

Table 3 - Calculation of Sodium Sulphate recovery in Kg of salt per tonne of fibre

$$\text{Sodium Sulphate kg of salt recovery} = \frac{\text{Quantity of sodium sulphate produced as by-product (Tonne)}}{\text{Fibre Production (Tonne)}}$$

[a] A higher rate of recovery might be theoretically achievable for this substance. The decision of setting the aspirational limit on 700 kg of salt per tonne of fibre as recovery rate (equivalent to 70% recovery) resides in the fact that a higher recovery process will require increased input of energy and steam, and this will lead to increased GHG emissions creating additional environmental pollution.

3.1.3 Recovery technologies within Viscose and Modal production

The below is a non-extensive list of available technologies, containing those specified in the Best Available Techniques for Polymer production applicable to viscose. (EUROPEAN COMMISSION - IPPC Bureau 2007). The following should be taken into consideration to increase recovery rates:

1. Operate spinning frames in houses.
2. Condense the exhaust air from spinning streets to recover CS_2 and recycle it back into the process.
3. Recover CS_2 from exhaust air streams through adsorption on activated carbon.
4. Applying exhaust air desulphurisation processes based on catalytic oxidation with Sulphuric Acid (H_2SO_4) production.
5. Reduce Zn from the wastewater by alkaline precipitation followed by Sulphide precipitation.
6. Recover sulphate from spinning baths

In addition to the above listed, there are several other technologies that have been applied in Viscose processes in recent years to improve its natural resource efficiency.

3.2. Best practices for resources consumption

3.2.1 Normalised consumption

The below listed parameters are defined as the amount of the raw material or natural resource input required to produce one tonne of fibre, being the raw material average input for Viscose and Modal fibre production process. To understand more about the production process, it is important to have a complete overview of the raw material average input consumption. To share this information, manufacturing facilities should calculate the consumptions on an annual base average of fibre production per site. The minimum average accepted is not less than one month.

Table 4 - Recommended consumption for Viscose and Modal (Staple fibre) per tonne of fibre[a]

Parameter	Unit	Recommended consumption for Viscose and Modal[23] - Staple Fibre
CS_2	Kg/ per tonne of fibre	80 - 100
Caustic		0.45 - 0.6
H_2SO_4	t/ per tonne of fibre	0.65 - 1.03
Zn	Kg/ per tonne of fibre	2 - 10
Pulp	t/ per tonne of fibre	1.010 - 1.065
Spin finish	Kg/ per tonne of fibre	3 - 5.3
NaOCl		0 - 70

3.3. Wastewater environmental impact

3.3.1 Wastewater parameters – Load per tonne of fibre

To understand the environmental impact of the discharged wastewater coming from a fibre manufacturing facility that produces viscose or modal staple fibres, it is necessary to provide context to the concentration testing required in the ZDHC MMCF Wastewater Guidelines. This requires measuring the amount of water involved in the fibre production process and determining the load per tonne of fibre, by linking the pollutant concentration with the water volume used in the fibre manufacturing. The calculation of the parameters listed in Table 5 shall be done using the monthly average of water flow from the fibre production process. The concentration used for this calculation shall be taken from the ZDHC MMCF Wastewater Guidelines reporting. The month that shall be selected to create the average water flow, shall be the same as the sampling of the reporting parameter.

[a] The applicability of this table for Modal staple fibre production shall be only for sites with mixed production of Viscose and Modal fibres. This table does not apply to facilities with production of Modal without Viscose production. And while ZDHC recognises the importance of Energy and Water consumption during the production process, the inclusion of these parameters in this document, will require further data collection and analysis.

Table 5 - Example of a full reporting year of a manufacturing facility

Reporting cycle	Parameter	Sampling month for reporting ZDHC MMCF Guidelines	Test report	Water Flow volume – month average	Load per tonne of fibre
1 - 2020	COD - Sea	January 2020	150 mg/L	January= 60m^3	9000
2 - 2020	COD - Sea	June 2020	150 mg/L	June= 60m^3	9000

Table 6 - Wastewater Parameters to be reported in Load per tonne of fibre

Wastewater Parameters –				
	Unit	Limit values		
		Foundational	Progressive	Aspirational
COD – to sea	Load[a]/tonne of fibre	9000	6000	3600
COD - to other bodies of water		7200	6000	3600
BOD - 5 day		1800	900	300
Zn		150	60	18

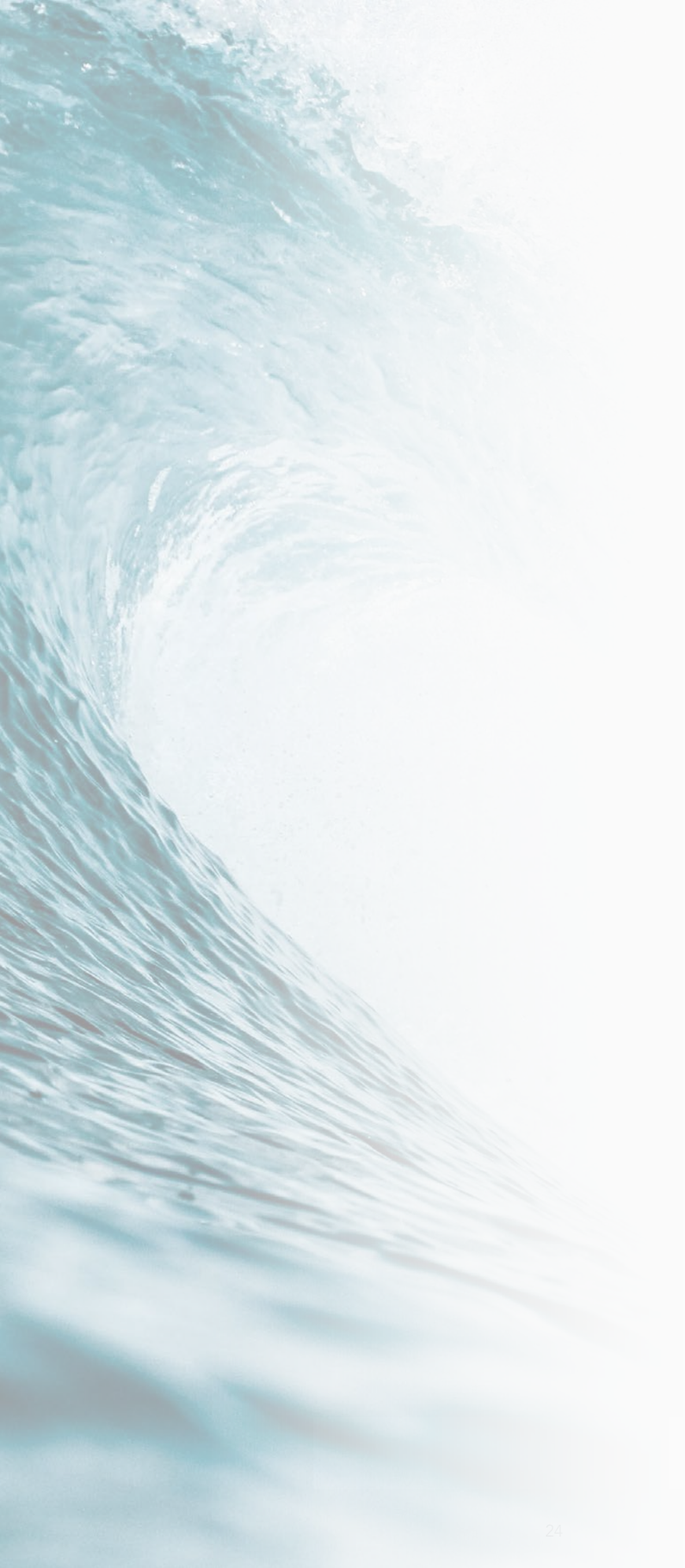
Table 7 - Calculation of Parameters to be reported in Load per tonne of fibre

Parameter load (**A**)	=	Concentration (**B**)	x	Water flow (**C**)
A= any of the parameters from Table 5		**B**= Concentration from wastewater testing. The test result used shall be the one from the testing of the parameters listed ZDHC MMCF Wastewater Guidelines.		**C**= Monthly average water flow. Calculated from the month when the sampling for the wastewater test-ing of the concentration parameter was collected.

[a] Load calculated on a 60m^3 water flow average.

To support the reporting of this document, facilities should provide the following information:

- Fiber production of the time period to calculate.
- Wastewater third party lab test results of the required parameters for the corresponding testing cycle.
- Wastewater flow of the month of the sampling conducted for the testing of the above-mentioned parameters.
- By-products produced, including but not limited to sodium sulphate, H_2SO_4, Barium sulphate, etc.



Chapter 2: ZDHC MMCF Interim Wastewater Guidelines

This document will address the expectations for wastewater discharge parameters and limit values related to the production of Man-Made Cellulosic Fibres.

This document includes the analytical testing methods and sampling procedures for wastewater testing, to enable brands and manufacturing facilities to share their testing results in a systematic and efficient manner via the ZDHC Gateway.

The expected outcomes of using this document are to:

- Ensure wastewater discharge does not have an adverse impact on communities and the environment.
- Provide a unified monitoring and testing programme for manufacturing facilities to systematically and efficiently share discharge/emission data with brands, and other interested parties.
- Increase operational efficiencies by defining a standard cadence for wastewater and reporting requirements which applies to all organisations that adopt this document.
- Define Pass/Fail limits for the analytical testing of hazardous substances in wastewater discharges and sludges produced during wastewater treatment operations. This Pass/Fail approach will apply to the ZDHC MRSL parameter: alkylphenol ethoxylates (APEOs) only.

1. Scope

This document applies to process-related discharged wastewater and sludge associated with the production of Man-Made Cellulosic Fibres from different feedstock sources, such as, but not limited to, wood and bamboo.

The fibres within the scope are:

- Viscose Staple Fibres
- Modal Staple Fibres

Testing and reporting of the below listed can be conducted against this document. It has to be observed that the limit values of this document were created for Viscose and Modal Staple Fibres only and that higher results can be reported, for the below listed fibres or production process. The reported data will be collected to help define its limit values[a].

- Viscose Filament Yarn
- Modal Filament Yarn
- Viscose and Modal produced in vertically integrated facilities where wastewater from the fibre production process is mixed with wastewater from dissolving pulp process.

Facilities with vertically integrated production including dyeing or finishing processes should also apply the most current ZDHC MRSL. Wastewater testing of such facilities shall include all the MRSL parameters listed in the ZDHC Wastewater Guidelines.

[a] Data collection purposes: In order to add Viscose and Modal filament yarn and dissolving of pulp for MMCF to the scope of this document the limit values will require collection of additional wastewater testing data and additional time for analysis.

2. Requirements

2.1. Minimum Requirements

The minimum requirements of this document are directly linked to the minimum requirements of the ZDHC Wastewater Guidelines. To learn more about the minimum requirements in the ZDHC Wastewater Guidelines click here.

2.2. Parameters and Limits

2.2.1 Wastewater Parameters

a. Conventional parameters

These parameters, their limits (foundational, progressive and aspirational), and recommended standard test methods for analysis are defined in Appendix A Tables 1.A (Conventional Parameters)

b. Additional parameters

These parameters, their limits (foundational, progressive and aspirational), and recommended standard test methods for analysis are defined in Appendix A Tables 1.B (Additional Parameters). In this appendix the applicable parameter and reporting limit of the ZDHC MRSL can be found.

c. Parameters specific to Man-Made Cellulosic Fibre production process

These parameters, their limits (foundational, progressive and aspirational), and recommended standard test methods for analysis are defined in Appendix A Tables 1.C (Parameters Specific to MMCF Production – Viscose staple fibre and Modal).

Where local legislation and/or permits, cover conventional parameters that are additional to those listed in this document, manufacturing facilities are expected to test for those additional parameters. These should be conducted according to the requirements applicable to local law (legal discharge permit) and the timeline identified by local authorities.

2.2.2 Sludge Parameters

Existing local legal regulations for the treatment and handling of industrial wastewater sludge shall be observed. If no such legal regulations exist, manufacturing facilities should implement disposal recommendations given in this guideline.

In order to manage the remaining sludge from the manufacturing processes of MMCF, it is necessary to test the sludge for the content of potentially harmful substances it contains.

The parameters suggested for testing to support decision-making on disposal can be found in Appendix A, Table 2.

In cases where the sludge from the wastewater treatment process is treated on the premises of the fibre producer, or it is incinerated in a designated incineration facility the testing of the proposed parameters should not apply. Wastewater sludge should be only incinerated by facilities with proof of long-term contract and holding proper technologies and permits.

Disposal recommendations:

- The incineration of Wastewater treatment sludge reduces the volume of the material to be disposed. It also destroys pathogens, decomposes most organic chemicals, and recovers the small amount of heat value contained in sewage sludge. Incineration is a pretreatment process to get residual ash that has just 10-20% of the original sludges' volume. It should also be considered that incineration also releases CO_2 and possibly other pollutants (cadmium, mercury, lead, dioxins) into the atmosphere. That incineration requires sophisticated systems to remove fine particulate matter (fly ash) and volatile pollutants from stack gasses. Therefore, wastewater sludge should be only incinerated by facilities holding proper technologies and permits.
- In cases where no proper incineration is available, wastewater sludge arising from production should only be disposed of at a secured landfill. It shall not be used for any kind of agricultural purpose, in case the below mentioned limit values are exceeded.
- The wastewater sludge from fibre processes might not be suitable for agricultural use due to its concentration of the mentioned pollutants. It might, however, be worthwhile testing the sludge for its contaminants in order to identify other sustainable usage options aligned with a circular approach and to follow best available practices.

2.3. General Principles for Sampling, Testing and Reporting

The general principles for sampling, testing and reporting of this document are directly linked to the latest version published in the ZDHC Wastewater Guidelines. To learn more click here.

2.4. Sampling Requirements

The sampling requirements of this document are directly linked to latest version published in the ZDHC Wastewater Guidelines. To learn more click here.

2.5. Testing Requirements

The testing requirements of this document are directly linked to the latest version published in the ZDHC Wastewater Guidelines. To learn more click here.

2.6. Methods for Analysis/Testing

The methods for analysis/testing recommended in this document are based on internationally-recognised standard water and wastewater testing methodologies, as well as government-recognised testing requirements in the European Union, the United States of America, China, and India.

Other requirements for the methods of analysis/testing of the conventional, additional and specific parameters for wastewater as mentioned in this document are directly linked to the methods for analysis/testing the conventional parameters for wastewater in the ZDHC Wastewater Guidelines. To learn more click here.

A. Conventional Parameters for Wastewater

Recommended standard methods for analysing these parameters are specified in Appendix A Tables 1.A.

B. Additional Parameters for Wastewater

Recommended standard methods for analysing these parameters are specified in Appendix A Tables 1.B.

C. Parameters specific to the Man-Made Cellulosic Fibre production process

Recommended standard methods for analysing these parameters are specified in Appendix A Tables 1.C.

D. Sludge

Recommended standard methods for analysing these parameters are specified in Appendix A Tables 2.

3. Testing and Reporting by ZDHC Accepted Laboratories

The sampling, testing, and reporting by ZDHC Accepted Laboratories of this document is directly linked to the testing requirements of the ZDHC Wastewater Guidelines.

To learn more click here.

3.1. Minimum Frequency for Sampling, Testing and Reporting

The minimum frequency for sampling, testing, and reporting of this document is directly linked to the minimum frequency for sampling, testing, and reporting of the ZDHC Wastewater Guidelines.

To learn more click here.

4. Data Reporting in the ZDHC Gateway – Wastewater Module Platform

The data reporting in the ZDHC Gateway – Wastewater Module Platform should follow the ZDHC Wastewater Guidelines.

To learn more click here.

5. Determining Conformance to this document

Sampling, testing and reporting requirements are the same for manufacturing facilities whether they discharge wastewater directly or indirectly. The only difference is what the resulting concentration data is compared to in order to determine conformance with this document.

Manufacturing facilities with direct discharge are expected to have:

- Achieved the foundational limits for conventional, additional, and specific parameters for the MMCF production process, set forth in Appendix A Table 1.A-1.C.

AND

- The applicable ZDHC MRSL wastewater parameter for discharged wastewater and in either sludge[a] **OR** in raw wastewater[a] to be at concentrations which are at, or below the reporting limits set forth in Appendix A Table 1.B for wastewater.

Manufacturing facilities with indirect discharge are expected to have:

- All conventional parameters complying with their agreements with the receiving central effluent treatment plant (CETP)

AND

- Applicable ZDHC MRSL Wastewater parameter in discharged wastewater and in either sludge[a] OR in raw wastewater[a] to be at concentrations that are at or below the reporting limits set forth in Appendix A Tables 1.B for wastewater.

[a] Option 1 and Option 2 can be found in the ZDHC Wastewater Guidelines, Appendix B.

6. Resolution of Non-Conformances

A. Definition of Non-Conformance

After testing is completed the test results may indicate non-conformance, which is defined below.

- For Wastewater Conventional, Additional, and Specific parameters for the MMCF production process. This is when test results:
  - Either exceed the foundational limits set forth in this document (Appendix A Tables 1.A-1.C) for direct discharge.
  - Or exceed the foundational limits of receiving CETP's requirements for indirect discharge manufacturing facilities.
- For the MMCF parameters applicable in the ZDHC MRSL Wastewater Parameter (APEOs): This is when test results exceed the reporting limits set forth in this document (Appendix A Tables 1.B).

B. Expectations for Manufacturing facilities with Non-Conformance(s)

If a test report indicates non-conformance as defined above, the supplier is expected to:

- Develop a root cause analysis and corrective action plan with a defined completion date. An input stream management review can be part of the initial root cause analysis, with actions such as checking if chemical formulations used in the production processes conform to the ZDHC MRSL; sending out specifications to textile raw material manufacturing facilities; or checking chemicals used in non-production related areas (e.g. APEOs used in cleaning products.)
- Submit the root cause analysis and corrective action plan with defined completion date on the ZDHC Gateway – Wastewater Module. Submission is expected to happen within thirty (30) days from the date of the laboratory report.
- Manufacturing facilities are encouraged to use the ZDHC Root Cause Analysis and Corrective Action Plan templates available in the ZDHC Gateway.
- Manufacturing facilities may resolve non-compliances and non-conformances in ways they deem best. For instance, they could contact clients (i.e. brands/retailers) to see if they can offer any advice; or reach out to technical experts to help determine the root cause and identify suitable solutions.

7. Expectations

The expectations of this document should follow the ZDHC Wastewater Guidelines. To learn more, click here.

a. Manufacturing facilities that directly discharge their wastewater into the environment are expected at minimum, to achieve the foundational limits of the conventional, additional and specific wastewater parameters (Appendix A, from Table 1A to1C).

b. Manufacturing facilities are encouraged to proactively develop and manage a written, data-driven plan to continuously improve their operations. This includes meeting the foundational limits of the conventional wastewater parameters and striving for achievement of progressive and aspirational limits.

c. Manufacturing facilities testing as per this document must demonstrate, that the concentration of applicable ZDHC MRSL parameters (APEOs - Appendix A, Table 1.B for wastewater) are below reporting limits

Chapter 2: Appendix A Parameters and Limit Values

Table 1.A Conventional Parameters limit values and test methods

Conventional Wastewater Parameters								
	Unit	Limit values			Test methods			
		Foundational	Progressive	Aspirational	International/ Europe	USA	China	India
PH	pH Units	6 - 9			ISO 10523	USEPA 150.1 SM 4500H^{+}-B	GB/T 6920	IS 3025 (Part 11)
Temp	°C	Δ15	Δ10	Δ5	N/A	USEPA 170.1 SM 2550-B	GB/T 13195	IS 3025 (Part 9)
Colour	{m-1] (436nm; 525; 620nm)	7; 5; 3	5; 3; 2	2; 1; 1	ISO 7887-B	N/A	N/A	IS 3025 (Part 4)
COD discharge to Sea	mg/L	150	100	60	ISO 15705 (in case deviating results then ISO 6060)	USEPA 410.4. SM 5220D**	HJ 828	IS 3025 (Part 58)
COD discharge to other bodies of water	mg/L	120	100	60				
BOD - 5-day Concentration	mg/L	30	15	5	EN 1899-1 ISO 5815-1	USEPA 405.1, SM 5210B	HJ 505	IS 3035 (Part 44) (BOD5)
Oil & Grease	mg/L	8	5	2	ISO 9377-1	USEPA 1664-B SM 5520-B or C	HJ 637	IS 3025 (Part 39) Infrared partition method
Total-N	mg/L	30	25	20	ISO 29441,11905	SM 4500N-C 4500N-B	HJ 636	IS 3025 (Part 34)
NH_4-N	mg/L	5	3	1	ISO, 6778, 11732, 5664	SM 4500NH3-C or D	HJ 665, HJ 666, HJ 535, HJ 536	IS 3025 (Part 34)
TSS	mg/L	70	50	30	ISO 11923	USEPA 160.2, SM 2540D	GB/T 11901	IS 3025 (Part 17)
Total-P	mg/L	3	1	0.5	ISO 6878, ISO 11885 (ICP-OES), ISO 17294-2 (ICP-MS)	USEPA 365.4, SM 4500P-J EPA 200.7 (ICP-OES), EPA 200.8 (ICP-MS)	GB/T 11893 HJ 700 (ICP-MS) HJ 670, HJ 671	IS 3025 (Part 31) IS 3025 part 65 (ICP-MS)
AOX	mg/L	5	2	0.2	ISO 9562	USEPA 1650	HJ/T 83-2001	CPPRI Saharanpur, AOX Analyzer, ISO 9562
Phenols	mg/L	1	0.5	0.1	ISO 14402 ISO 6439 [Chloroform extraction]	SM 5530 B, C&D	HJ 503	IS 3025 (Part 43)

Conventional Wastewater Parameters (continued)								
	Unit	Limit values			Test methods			
		Foundational	Progressive	Aspirational	International/ Europe	USA	China	India
Toxicity[a] • Luminous Bacteria or • Fish egg test or • Daphne or • Algae (Toxicity is an optional parameter and results from this test should be considered as informational.)	GI GE GD GAL	32 2 12 16			Fish egg test, Daphne and/or Algae test: DIN EN ISO 11348-2: 1999-04 (L 34-2) DIN EN ISO 11348-2: 2009-05 (L 52) DIN EN ISO 11348-1: 2009-05 (L 51)	SM 8050-B	N/A	N/A

[a] The data collection of Toxicity will be used to understand the wastewater content, which might result in a further review of this table.

Table 1.B Additional Parameters limit values and test methods

Additional Wastewater Parameters								
	Unit	Limit values			Test methods			
		Foundational	Progressive	Aspirational	International/ Europe	USA	China	India
Chromium, total	mg/L	0.2	0.1	0.05	ISO 11885, ICP-OES, ISO 17294-2 ICP-MS	USEPA 200.7. USEPA 200.8.	GB 7466, HJ700	IS 3025 (Part 52)
Cadmium[a]		0.1	0.05	0.01	ISO 11885, ICP-OES, ISO 17294-2 ICP-MS	USEPA 200.7. USEPA 200.8.	GB7475, HJ700	IS 3025 part 41, AAS, Instrumental Method
Copper[a]		1	0.5	0.25	ISO 11885, CP-OES, ISO 17294-2 ICP-MS	USEPA 200.7. USEPA 200.8.	GB7475. HJ700	IS 3025 part 42, AAS, Instrumental Method
Nickel[a]		0.5	0.2	0.1	ISO 11885, ICP-OES, ISO 17294-2 ICP-MS	USEPA 200.7. USEPA 200.8.	GB 11907. HJ700	IS 3025 part 54, AAS, Instrumental Method
Chromium (VI)		0.05	0.005	0.001	ISO 18412	USEPA 218.6	GB 7467	IS 3025 part 52
Lead[a]		0.1	0.05	0.01	ISO 11885, ICP-OES, ISO 17294-2 ICP-MS	USEPA 200.7. USEPA 200.8.	GB7475. HJ700	IS 3025 part 47 AAS, Instrumental Method
Mercury		0.01	0.005	0.001	ISO 12846 or ISO 17852, ISO 17294-2 (ICP-MS)	USEPA 245.1, 245.2, EPA 200.8 (ICP-MS)	HJ 597, HJ 700	IS 3025 (Part 48) IS 3025 part 65 [SIM mode]
Σ Hydrocarbons		5	3	1	-	USEPA 1664 B SM 5520-F	-	-
	Unit	**Reporting limit**			**Test methods**			
APEOs	µg/L	5.0			NP/OP: ISO 18857 -2 (modified dichloromethane extraction) or ASTM D7065 (GC/MS or LC/MS(-MS) OPEO/NPEO (n>2): ISO 18254-1 OPEO/NPEO (n=1,2): ISO 18857-2 or ASTM D7065			

[a] These parameters will be reviewed once sufficient data is gathered, in order to make a decision with a science-based approach.

Table 1.C Specific Parameters related to MMCF production limit values and test methods

Parameters Specific to the production of Viscose and Modal (staple fibre)								
	Unit	Limit values			Test methods			
		Foundational	Progressive	Aspirational	International/ Europe	USA	China	India
Zn	mg/L	2.5	1.0	0.5	ISO 11885 ICP-OES ISO 17294-2 ICP-MS	USEPA 200.7. USEPA 200.8.	GB 7475. HJ 700	IS 3025 part 49 AAS, Instrumental Method
Sulphide	mg/L	2	1	0.5	ISO 10530	SM 4500S^2-C&D 4500S^2-G	GB/T 16489 HJ 824 (flow injection methylene blue)	IS 3025 part 29
CS_2		0.5	0.2	0.1	ISO 15680 ISO 11423-2 (headspace method)	USEPA 8260B	HJ 810, GB/T 15504 (headspace method)	N/A

Table 2 Parameters for sludge testing and test methods[a]

Substance or Substance Group	Unit	Reporting limit	Test methods			
			International/ Europe	USA	China	India
AOX - Leachate	mg/kg	10	DIN 38414 S18: 2019	US EPA 1650	HJ/T 83:2001 ISO 9562:2004	IS 3025 Part 70
EOX[b] - Dry sludge[c]		0.2	DIN 38414-S 17, 2017-01	US EPA 9023	-	-
TOC[d] - %		1000	DIN EN 15936: 2012-11	US EPA 9060	HJ 695:2014 HJ 658:2013 HJ 615:2011	IS 2720 Part 22 IS 3025 Part 69
Heavy metals - Zn Cu Ni Pb Cd Hg		1	DIN EN ISO 17294-2: 2017-01 Acid Digestion, ICP or ICP/MS	US EPA 200.8 US EPA 3050	HJ 832:2017 HJ 803:2016 CJ/T221-2005 HJ 781:2016 HJ 766:2015	IS 3025 Part 2, 65, 66

[a] The data collection for these parameters will be used in future to understand the sludge content. This might result in a further review of this table.

[b] If EOX results are positive, then AOX shall be tested.

[c] Dry sludge: Either partially dried (60% to 80% DS) or completely dried, up to approx. 80% to 90% DS. The percentage of the DS has to be included in the final calculation.

[d] This parameter should be considered in those facilities where sludge from the MMCF facility is connected to other type of facility.

Chapter 3: ZDHC MMCF Air Emissions Guidelines

This document will address the integrated expectations of the emissions to air, related to the priority hazardous chemicals used during production processes of MMCF.

This document specifies a unified set of parameters and limit values related to the production of Man-Made Cellulosic fibres. It also includes the analytical test methods and sampling procedures, with the ultimate objective of allowing brands and manufacturing facilities to share their testing results in a systematic and efficient manner.

The expected outcomes of using this document are to:

- Address emissions to air from the fibre production of MMCF and to minimise adverse impact in the environment and surrounding communities.
- Provide a unified approach for monitoring and testing for manufacturing facilities, for them to systematically and efficiently share emission data with brands(s) they work with, and/or other interested parties.
- Increase operational efficiencies by defining a standard cadence for air emission monitoring and reporting requirements, applicable to all brands and manufacturing facilities adopting this document.

1. Scope

This document applies to process-related air emissions associated with the production of Man-Made Cellulosic Fibres from different feedstock sources, such as, but not limited to, wood and bamboo.

The fibres within the scope are:

- Viscose Staple Fibres
- Modal Staple Fibres

2. Requirements

The below listed basic expectations are considered to be out of scope of this document, and although these are considered to be basic requirements, ZDHC will not be held liable for its verification.

Manufacturing facilities are expected to:

- Have a valid license to operate.
- Understand any air emissions dilution of exhausted systems to purposefully minimise concentration of pollutants is prohibited.

2.1. Minimum Requirements

- Quantify and track emissions of all parameters, consistent with standards and best practices of measurement and transparency.
- Follow generally accepted process engineering best practices for air emissions, to minimise environmental impact.

2.2. Inventory Management

To implement this guideline, all facilities shall have a live and functioning inventory management programme.

- Chemical Classification is required for input related chemical products which may have an impact on air emissions.
- Potential to Emit (PTE) can be calculated for key pollutants, as listed throughout this guideline.

2.3. Parameters and Limits for Viscose and Modal - Staple Fibre

Within the fibre production of viscose and modal there are two major Sulphur emissions, CS_2 and H_2S, originating from CS_2. These should be condensed and recovered using different state of the art technologies such as condensation, Wet Sulphuric Acid (WSA) and Carbon Adsorption Process (CAP), mentioned in the EU BAT reference BAT technologies.

This document will focus on the following:

A. Sulphur emission to air
B. Ambient air outside the facility

Parameters and limit values can be found in Appendix A.

3. General Principles for Monitoring, Testing and Reporting

The approach taken to monitor the selected parameters, include direct and indirect measurement methods. Complementing the mass balance (indirect method) the testing of ambient air (direct method) shall be conducted, to corroborate that those concern substances are not present above the given concentration.

To streamline efforts:

- Manufacturing facilities are encouraged to align the testing of this document with the testing required in their legal permit.
- Manufacturing facilities are expected to allow brands to conduct unannounced visits by ZDHC Accepted Laboratories or third-party verification bodies. Terms in which unannounced visits shall conducted are to be discussed with soliciting brand.

3.1. Monitoring

It is imperative that a measurement system or a continuous sampling/testing procedure shall be established in order to measure all necessary parameters. Any fugitive emissions shall be controlled and avoided using state-of-the-art technologies. It is therefore important, that MMCF manufacturers shall implement plans to reduce or avoid fugitive emissions.

3.2. Mass balance for the establishment of Sulphur Emission to air

When establishing a methodology with corresponding limit values for substances of concern, it is important that the selected methodology is internationally accepted and implemented. The methodology requires a holistic balancing of all incoming and outgoing material flows, and it recommended to follow in principle the Directive 2010/75/EU of the European Parliament on industrial emissions - integrated pollution prevention and control. (European Union, 2010)

3.2.1 Sulphur emission to air calculation

By applying a mass balance, the effectiveness of the emission control of Sulphur release to air can be calculated. Any methods used should include the total mass of Sulphur removed from the exhaust gases. Depending on the outputs, it can be either in solid form or liquid form. Those recovered chemicals can be either re-used as part of the process or sold as a product. Some remaining Sulphur can be trapped in the sludge or liquid streams.

The formula for the mass balance can be found in Appendix A, Table 1.B.

3.3. Control Technologies for Sulphur release to Air

The viscose industry uses several technologies to control the emission of Sulphur to air during the manufacturing process. The major technologies in use in the industry are listed Appendix A, Table 1.B along with the product recovered.

3.4. Ambient Air Testing

Manufacturing facilities shall test the ambient air concentration outside the facility, of the key substances involved in the viscose and modal production process (CS_2 and H_2S) to prove that the emissions-to-air do not exceed reporting limits set in this document.

The intention of air sampling and corresponding analytical testing, is to identify whether harmful substances related to the manufacturing process are present in the ambient air and if the concentration of these substances is within or above given limits.

In order to follow one standardised approach for the measurement of ambient air in the surrounding of the production facility, the ZDHC proposal therefore is attached in Appendix B.

3.5. Test Methods

Where specific testing is required, standardised test methods shall be utilised, such as:

- Standard test methods shall be chosen for the region where the manufacturing occurs.
- In the absence of local or regional test methods, internationally recognised test methods, often recommended by governmental organisations shall be used, such as the ISO, EPA or GB.

3.6. Minimum Reporting Frequency

- Sampling, testing, and reporting of ambient air parameters shall be completed at least twice a year. The reporting shall be at latest, following the 30 April and 31 October reporting deadlines.
- Sampling, testing and reporting can occur anytime during each of the reporting cycles, so long as there are at least three months between sampling for the two reporting deadlines. To illustrate:

April 30 reporting deadline	October 31 reporting deadline
• Sampling: 30 March • Testing: 1 April • Reporting: 18 April	• Sampling: 2 July (this is at least three months after the above example sampling date for the 30 April reporting deadline) • Testing: 3 July • Reporting: 30 July

- The reporting frequency for the mass balance calculation will be based on an annual verification. The reporting cycle shall start 1 May and will have a reporting deadline of 30 April. The reporting deadline shall be completed of 30 April of each year.
- Where a test shows that a supplier does not meet the requirements of this document, manufacturing facilities shall identify the root cause, resolve the issue and re-test ambient air as often as necessary to demonstrate the issue has been resolved.

Chapter 3: Appendix A

Table 1.A Parameters and Limit Values for production emissions and concentration of CS_2 and H_2S in ambient air related to fibre production of Viscose and Modal

ZDHC limits	Sulphur emissions to air calculated through Mass balance	CS_2 (ambient air concentration outside the facility) - Reporting limit	H_2S (ambient air concentration outside the facility) - Reporting limit
Unit	kg/ton dry MMCF (annual basis)	mg/Nm^3	Reporting limit
Foundational	35 [a]	0.10 [b]	0.10 [b, c]
Progressive	20 [d]		
Aspirational	12 [d]		

Disclaimer: Due to an active review process of the TA Luft for Rayon and the EU BAT BREF WGS, CS_2 and H_2S in total air[a] will not be included in this document, which were the basis of the literature review used in the creation of this document.

[a] Based on average between norms assigned to new plants in India and EU Ecolabel criteria for textile products.
[b] Ministry of environment, forest and climate change of India from January 17, 2018.
[c] In the next review process of this document the understanding of the possibilities of reaching a lower detection limit will be discussed.
[d] EU BAT BREF POL recommendation

Table 1.B Mass balance of special Sulphur flows

Formula for Mass Balance:

Sulphur emission to air = I1 – (O1 + O2 + O3 + O4 + O5 + O6 + O7)

Inputs		Notes	L/S/G	Test method
I1	CS_2 addition to reactor including fresh input and CS_2 recovered from the pro-cess (Churn/Xanthator).		Liquid	As per Flowmeter/ Tank Level Difference.
Recovery/Recycle/Outputs				
O1	CS_2 recycled by condensation re-covery.		Liquid	As per Flowmeter/ Tank Level Difference.
O2	CS_2 recycled by activated carbon adsorption.		Liquid	As per Flowmeter/ Tank Level Difference.
O3	Removal of H_2S as NaHS or Na_2S by alkaline wash and spray.	Effluent/By-Product.	Liquid /Solid	Method 1: Product of inlet Gas flow by flowmeter and differ-ence in concentration of CS_2/H_2S at inlet & outlet of the reactor or Wet scrubber. Method 2: Product of Quantity as per Tank Level Difference and concentration as per Lab or Density meter. Estimate equivalent Sulphur by calculation.
O4	Converted H_2S and CS_2 into H_2SO_4 by conversion into Sulphuric Acid with oxidation.	Wet Sulphuric acid (WSA) Technology.	Liquid	Product of Quantity (as per Flowmeter or Tank Level Difference) and concentration as per Lab or Density meter. Estimate equiva-lent Sulphur by calculation. Deduct the supplementary Sulphur if fed (any).
O5	Converted H_2S and CS_2 into SOx by exhaust gas incineration/ boil-er followed by scrubbing of flue gases by lime to produce Gyp-sum.	Flue gas de-sulphurisation.	Solid	Calculation given below.
O6	Converted H_2S, CS_2 or both to Sulphur by biological or catalytic processes or redox process.		Solid/Liquid	Method 1: Inlet Gas flow by flowmeter and difference in con-centration of CS_2/H_2S at inlet & outlet of the reactor or Wet scrubber. Method 2: Product of Quantity as per Tank Level Difference and concentration as per Lab or Density meter. Estimate equivalent Sulphur by calculation.

Calculation Method for O5 (Gypsum):

Incineration in coal fired boiler

Sulphur is fed to the boiler from the viscose process and also there is Sulphur in coal, both get converted to SOx in boiler/incinerator. The SOx are scrubbed by lime to make Gypsum. The flue gas from boiler have some remaining unscrubbed Sulphur as SOx. The purity of Gypsum varies depending on the flue gas desulphurization process applied. Calculation method to estimate the Sulphur scrubbed by Gypsum: mass balance of Sulphur across the boiler/ incinerator.

Sulphur In

A= Calculation of Sulphur with Exhaust gases of Viscose: Product of Exhaust gas flowrate and concentration of CS_2 & H_2S (calculated as equivalent Sulphur) / day

B= Sulphur content in Coal (total of the day) - Product Coal fed to boiler /day and Sulphur content in coal (as measured in Lab)

Sulphur Out

C= Sulphur out with Flue gases: product of flowrate of flue gases and SOx (as equivalent Sulphur) / day

Sulphur Released to air from Viscose Staple Fibre Process

D= (A x C)/(A+B)

O5 = A-D

Chapter 3: Appendix B Measurement of ambient air in the surroundings of the production facility

Proposal

The definition of the assessment area must enable the proper assessment of the problem in question; the concentration of H_2S and CS_2 and the possible impact on the surrounding environment.

It is proposed that the assessment area begins at the fence and is completely within a circumference around the center of the emission within radius of maximum 1 kilometer from the source.

Sampling and testing by an accredited laboratory shall be done at least once a year considering:

1. That production is running;

AND

2. The direction of the wind and potential areas are covered. It is imperative that an air sampling protocol contains all relevant and important information applicable to the air sampling procedure.

Relevant Organisations and Contributions

- Canopy click here
- Bluesign System click here
- The European IPPC Bureau (EU-BAT BREF Reference Document on Best Available Techniques in the Production of Polymers August 2007) click here
- The Collaboration for Sustainable Development of Viscose (CV) click here
- EU Eco Label click here
- World Health Organization – Making Water a Part of Economic Development click here
- ZDHC Roadmap to Zero Programme click here

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End Notes

i EUROPEAN COMMISSION - Reference Document on Best Available Techniques in the Production of Polymers August 2007