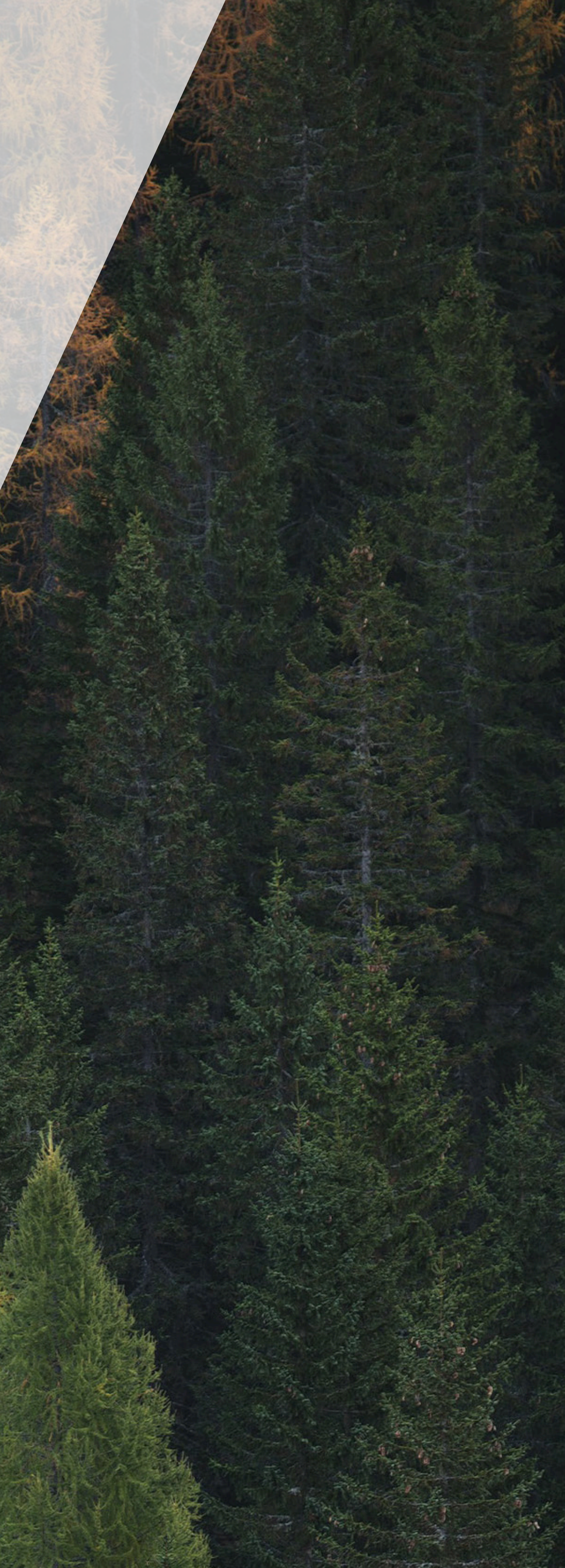
ZDHC

ZDHC Man-made Cellulosic Fibre (MMCF) Guidelines

Version 2.0

January 2023



NOTES

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a. Compliance with, or take the place of, legal or regulatory requirements. Examples might include: stricter legal, local or regional regulatory requirements on the use, storage and transport of chemical products; or other requirements relating to the handling and disposal of chemical products, which shall supersede any requirements as set forth in this document.
b. Compliance with, or conformance to, any national or international environmental or workplace safety requirements, including, but not limited to, relevant regulations and/or standards.
c. Nor do the ZDHC Man-Made Cellulosic Fibres (MMCF) Guidelines replace any national or international environmental or workplace safety requirements including, but not limited to, regulations and/ or standards.

The ZDHC Man-Made Cellulosic Fibres (MMCF) Guidelines is not intended nor can be used as a statement of legal requirements.
ZDHC refers to the UN GHS (Globally Harmonized System of Classification and Labelling of Chemicals) as the internationally recognised standard for hazardous material classification and labelling. All the other National/Regional existing schemes, derived from the implementation of the GHS, have to be considered included in the list of the accepted ZDHC standards for this purpose. To simplify the ZDHC Man-Made Cellulosic Fibres (MMCF) Guidelines comprehension, ZDHC uses GHS throughout as its reference for Hazard Statements and Pictograms in SDS and labels in order to avoid local variables.

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Revision History

Version Number	Changes	Time of Publication
Version 2.0	• Scope expansion to include viscose filament yarn, lyocell, cuprammonium rayon (cupro) and cellulose acetate (acetate) • Guidelines and requirements defined for chemical recovery, wastewater and sludge discharge and air emissions discharge for the fibres included in the expanded scope • Testing of toxicity of wastewater (which was optional in MMCF Wastewater Guidelines V1.0 for Viscose and Modal staple fibres) is deleted from the requirements in MMCF Wastewater Guidelines V2.0 for viscose staple fibre and modal staple fibres	January 2023

Related Work

This document is one part of a series of solutions provided by ZDHC. MMCF fibre and filament manufacturing facilities are expected to comply with the solutions applicable to them, considering the type of processes conducted in the facility. The following documents must be taken into account:

ZDHC MMCF Responsible Fibre Production Guidelines V2.0

To be interpreted also with:

- ZDHC Wastewater Guidelines V2.1
- Chemical Inventory List (CIL)

ZDHC MMCF Wastewater Guidelines V2.0

To be interpreted also with:

- ZDHC Wastewater Guidelines V2.1
- ZDHC Sludge Reference Document V1.0
- ZDHC Wastewater and Sludge Laboratory Sampling and Analysis Plan (SAP) V2.1

ZDHC MMCF Air Emissions Guidelines V2.0

To be interpreted also with:

- ZDHC Air Emission Guidelines (under development)

Definitions

The following words are used to indicate requirements, recommendations, permissions and possibilities during implementation of our documents:

- 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 Effluent Treatment Plant
CIL	Chemical Inventory List
VSF	Viscose Staple Fibre
VFY	Viscose Filament Yarn
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 standard)
HJ/T	Chinese recommended environmental protection standard (Chinese industry standard)
IPE	Institute of Public and Environmental Affairs – Chinese non-governmental organisation
ISO	International Organization for Standardisation
LC	Liquid Chromatography
MMCF	Man-Made Cellulosic Fibres
ZDHC MRSL	ZDHC 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 of Requirements in MMCF Guidelines V2.0

<table>
<tr><th>Guidelines</th><th>Requirements</th><th>Monitoring Mechanism</th></tr>
<tr><td colspan="3">MMCF Responsible Fibre Production Guidelines V2.0</td></tr>
<tr><td>Viscose staple fibre</td><td>1. % sulphur recovered and feed back into process
2. Sodium sulphate (kg per tonne of fibre) recovered
3. Wastewater environmental impact of some parameters as load-based values (mg/tonne of fibre)
4. Share raw material consumption data</td><td rowspan="4">1. Self-evaluation & monitoring

2. Supplier Platform – MMCF Module (proposed)</td></tr>
<tr><td>Lyocell</td><td>1. NMMO recovery %
2. Wastewater environmental impact of some parameters as load-based values (mg/tonne of fibre)
3. Share raw material consumption data</td></tr>
<tr><td>Viscose filament yarn</td><td>1. Sodium sulphate (kg per tonne of fibre) recovered
2. Wastewater environmental impact of some parameters as load-based values (mg/tonne of fibre)
3. Share raw material consumption data</td></tr>
<tr><td>Cupro</td><td>1. Copper, ammonia recovery %
2. Share raw material consumption data</td></tr>
</table>

<table>
<tr><td>Acetate</td><td>1. Acetone recovery %
2. Wastewater environmental impact of some parameters as load based values (mg/tonne of fibre)
3. Share raw material consumption data</td><td>1. Self-evaluation & monitoring

2. Supplier Platform – MMCF Module (proposed)</td></tr>
<tr><td colspan="3">MMCF Wastewater Guidelines V2.0</td></tr>
<tr><td>Viscose staple fibre</td><td>1. Conventional parameters: pH, temperature, colour, COD, BOD, oil and grease, Total-N, Ammo.-N, TSS, Total-P, AOX, phenol
2. Additional: total Cr, Cd, Cu, Ni, Cr6, Pb, Hg, Σ hydrocarbons, APEOs
3. Specific: Zn, sulphide, CS_2</td><td rowspan="4">Two cycles of testing (April and October) through ZDHC Approved Wastewater Laboratories, with test reports uploaded on the ZDHC Gateway</td></tr>
<tr><td>Lyocell</td><td>1. Conventional parameters: pH, temperature, colour, COD, BOD, oil and grease, Total-N, Ammo.-N, TSS, Total-P, AOX, phenol
2. Additional: total Cr, Cd, Cu, Ni, Cr6, Pb, Hg and APEOs</td></tr>
<tr><td>Viscose filament yarn</td><td>1. Conventional parameters: pH, temperature, colour, COD, BOD, oil and grease, Total-N, Ammo.-N, TSS, Total-P, AOX, phenol
2. Additional: total Cr, Cd, Cu, Ni, Cr6, Pb, Hg, Σ hydrocarbons, APEOs
3. Specific: Zn, sulphide, CS_2</td></tr>
<tr><td>Cupro</td><td>1. Conventional parameters: pH, temperature, colour, COD, BOD, oil and grease, Total-N, Ammo.-N, TSS, Total-P, AOX, phenol
2. Additional: total Cr, Cd, Cu, Ni, Cr6, Pb, Hg, Σ hydrocarbons, APEOs</td></tr>
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<tr><th>Guidelines</th><th>Requirements</th><th>Monitoring Mechanism</th></tr>
<tr><td colspan="3">MMCF Wastewater Guidelines V2.0 (continued)</td></tr>
<tr><td>Acetate</td><td>1. Conventional parameters: pH, temperature, colour, COD, BOD, oil and grease, Total-N, Ammo.-N, TSS, Total-P, AOX, phenol
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<tr><td colspan="3">MMCF Air Emissions V2.0</td></tr>
<tr><td>Viscose staple fibre</td><td>1. Ambient air parameters to be tested
2. CS_2 and H_2S to be tested
3. Calculation of sulphur emissions to air through mass balance estimation</td><td rowspan="5">1.Self-evaluation and monitoring

2.Supplier Platform – MMCF Module (proposed)</td></tr>
<tr><td>Lyocell</td><td>Not applicable. (Because NMMO is easily dissolved in water and is not volatile, air emission in the lyocell process is minimal. The waste air out of the spinning process contains a small amount of NMMO which can be recovered by scrubbers at the vent.)</td></tr>
<tr><td>Viscose filament yarn</td><td>1. Ambient air parameters to be tested
2. CS_2 and H_2S to be tested</td></tr>
<tr><td>Cupro</td><td>1. Ambient air parameters to be tested
2. NH_3 to be tested</td></tr>
<tr><td>Acetate</td><td>1. Acetone emissions to air to be calculated
2. Mass balance calculations shall be used to estimate the acetone emissions to air</td></tr>
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For note taking:

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Contents

Background

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.

To address the use and discharge of hazardous chemicals in man-made cellulosic fibre manufacturing, ZDHC published the ZDHC MMCF Guidelines V1.0 in April 2020. These guidelines were focussed on the viscose staple fibre manufacturing sector. It was felt that the scope of these guidelines should be expanded to other fibre categories in the MMCF sector, such as lyocell, viscose filament yarn (VFY), cuprammonium rayon (cupro) and cellulose acetate (acetate). A collaborative and aligned approach to these fibres would generate cleaner outputs from production while including a circular approach to their processes. At the same time, due to the publication of the ZDHC Wastewater Guidelines V2.1 and the Sludge Reference Document V1.0, it was imperative to align the Wastewater Guidelines for viscose staple fibre in the V1.0 document with these new requirements.

A task team drawn from ZDHC contributors was set up to study the above and update the guidelines to the ZDHC MMCF Guidelines V2.0 for the scope expansion.

Objective

The ZDHC MMCF Guidelines V2.0 addresses integrated expectations for discharged 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 V2.0
- ZDHC MMCF Wastewater Guidelines V2.0
- ZDHC MMCF Air Emissions Guidelines V2.0

The ZDHC MMCF Guidelines V2.0 should be implemented as one guideline because the outputs from the production process of fibres cannot be seen as standalone outputs. These three documents provide guidance for an aligned industry approach. With this set of documents, ZDHC appeals to its contributors and the entire MMCF industry to improve the quality of discharged industrial wastewater and production-related emissions to air. 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, sodium sulphate, NMMO, ammonia, copper and acetone.

ZDHC hopes to instigate 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 BREF POL) by aiming to achieve integrated prevention and control of pollution arising from production, leading to a high level of environmental protection (European Commission – IPPC Bureau 2007).

This document does not include requirements for the process of converting wood to dissolving pulp for MMCF fibres and the work to add this process to the scope of the guidelines, as well as the publication date, is yet to be defined.

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 recovery rates of the proposed parameters:

- Foundational: First level to be achieved by manufacturing facilities at a minimum
- Progressive: An intermediate level to be achieved by manufacturing facilities through the application of technologies such as, but not limited to, those mentioned in EU BAT BREF Reference Document on Best Available Techniques for the Production of Polymers (EU 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 EU BAT BREF Reference Document on Best Available Techniques for the Production of Polymers (EU BREF POL) applicable to viscose and beyond

Manufacturing facilities shall proactively develop and manage a data-driven, continuous improvement plan to achieve the requirements at each level.

To learn more about the continuous improvement roadmap, see ZDHC MMCF Guidelines Implementation Plan V2.0.

Chapter 1: ZDHC MMCF Responsible Fibre Production Guidelines

The objective of this guideline is to address the expectations for:

- Process chemical recovery rates
- Wastewater environmental impact in terms of load per tonne of fibre or filament produced
- Best practices in production of MMCF

1.0 Scope

The feedstock in scope for production includes, but is not limited to, wood and bamboo, and covers outputs proceeding from the dissolving of fibre and filament for the following MMCF fibres:

- Viscose staple fibres (VSF)
- Modal staple fibres
- Viscose filament yarn (VFY)
- Lyocell
- Cuprammonium rayon (cupro)
- Cellulose acetate (acetate)

2.0 Best Practices for Fibre Feedstock

The selection of feedstock for the production of MMCF can have a 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 inputs. The following subsections are some recommended best practices that should be implemented by organisations.

2.1 Raw Material Sourcing

a. Organisations shall have a responsible raw material policy defining the sourcing of wood, pulp, and pulp fibre, eliminating sourcing from ancient and endangered forests, endangered species habitats and other controversial sources. To support this policy, organisations:
   ii. Should conduct a CanopyStyle verification audit to assess the risk of sourcing from ancient and endangered forests and other controversial sources
   iii. Shall include a preference for Forest Stewardship Council (FSC) or Programme for the Endorsement of Forest Certification (PEFC) certified inputs

b. To ensure transparency throughout the value chain, organisations should have a proper chain of custody system that includes, but is not limited to, blockchain-based traceability or use of Unique Trace.

2.2 Circularity and Recycled Feedstock

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

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

a. Organisations should have a sourcing strategy that includes commitments to increase the percentage of raw material originated from next generation feedstock[a], with clearly defined feedstock, targets and timelines for adopting materials originated from next generation feedstock.
b. To support the use of recycled feedstock, organisations should take part in the Textile Exchange Recycled Claim Standard certification programme at a minimum.

a ZDHC refers to next generation feedstock as the one originated from alternative and recycled feedstock.

3.0 Responsible Production of MMCF

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 not only include alternative non-virgin feedstock sources but also address the recovery of chemicals and by-products related to the MMCF production process.

3.1 Viscose and Modal (Staple Fibres)

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 onsite production processes or sold as by-product. To achieve the recovery percentage of these chemicals (sulphur and sodium sulphate) in this document, control technologies and recovery treatments should be applied.

Sulphur recovery – treatment 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 and spin bath, coupled with either of the following upstream processes 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 sulphur recovery technologies available within 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 technologies within viscose and modal (staple fibres) production are specified in the Best Available Techniques for Polymer production applicable to viscose and modal staple fibres (EUROPEAN COMMISSION – IPCC Bureau 2007). In addition, there are several other technologies that have been applied in viscose processes in recent years to improve its natural resource efficiency.

Recovery Rates
Correlation of sulphur release to air and the corresponding sulphur recovery rates in percentage of CS_2 charged in feed

ZDHC Levels	Total Sulphur to Air (kg/tonne fibre)	Corresponding sulphur recovery in % of CS_2 added in the process
Foundational	35	85%
Progressive	20	92%
Aspirational	12	95%

Sodium sulphate recovery rates

ZDHC Levels	Sodium sulphate recovery %
Foundational	50
Progressive	60
Aspirational*	70

* A higher rate of recovery for Aspirational level is theoretically achievable, but such higher levels will require increased input of energy and steam, which can lead to increased GHG emissions, creating additional environmental pollution.

Calculation of sodium sulphate recovery

$$\text{Sodium sulphate recovery (\%)} = \frac{\text{quantity of sodium sulphate produced as by-product (kgs)} \times 100}{\text{viscose or modal fibres produced (tonne)}}$$

3.2 Viscose Filament Yarn (VFY)

Chemical Recovery
There is no proven technology for CS_2 recovery from waste gases generated in viscose filament yarn manufacturing, either in spool spun yarn (SSY) or continuous spun yarn (CSY) or pot spun yarn (PSY). Theoretically, SSY is feasible in technical treatment, and some facilities are equipped with related equipment, but the proportion of CS_2 generated is not high. This means that all CS_2 inputs need to be treated or discharged rather than recycled in VFY production.

Sodium Sulphate recovery rates

ZDHC Levels	Sodium sulphate recovery %
Foundational	60
Progressive	65
Aspirational	70

Calculation of sodium sulphate recovery

$$\text{Sodium sulphate recovery (\%)} = \frac{\text{quantity of sodium sulphate produced as by-product (kgs)} \times 100}{\text{VFY produced (tonne)}}$$

3.3 Lyocell

Chemical Recovery

The core part of the Lyocell process is the direct dissolution of cellulose through NMMO (N-methyl-morpholine-n-oxide). The solvent, NMMO, is able to dissolve cellulose physically without any chemical pre-treatment. The important environmental issue in lyocell production is the recovery of NMMO. During the production of Lyocell, after washing out residual NMMO, spin finish is applied and the fibre is dried and packed.

NMMO Recovery – Treatment Methods and Control Technologies

NMMO is recovered through a multi-stage cleaning process, including filtration, purification (ionic exchange) and evaporation.

NMMO (in certain concentrations) can be recovered at a very high recovery rate. Meanwhile, water that is regained during the evaporation step is recycled back into the washing section of the fibre line.

NMMO recovery rates

ZDHC Levels	NMMO recovery (%)
Foundational	99.5
Progressive	99.7
Aspirational	99.8

Calculation of NMMO recovery

Recovery rate of NMMO (%) = [1- (NMMO loss / NMMO consumption)] x100

- NMMO loss = NMMO in wastewater to WWTP + NMMO remaining on product + NMMO remaining on waste
- NMMO consumption = NMMO fresh input + NMMO recovered and recycled

Alternatively, this could also be calculated only through mass balance:

- Recovery rate of NMMO = (1- (NMMO net input / NMMO consumption) %

Because in the process NMMO is present in different concentrations, for the calculation all concentrations must be converted to 100%.

3.4 Cupro

Chemical Recovery

During cupro production, copper and ammonia are used as cellulose solvents and are recovered by closed-loop process. Copper and ammonia discharged in wastewater are recovered using various wastewater treatment technologies. In addition, some ammonia escapes into the atmosphere as a gas and is recovered by scrubbing techniques and transferred to wastewater.

Copper and Ammonia Recovery – Treatment Methods and Control Technologies

During the production of cupro, copper and ammonia in wastewater are recovered by a multi-stage process.

- Copper is recovered mainly by sedimentation separation and ion exchange
- Ammonia is recovered mainly by distillation and ion exchange.

Ammonia gas that escapes is captured by wet scrubber and the captured ammonia is recovered through the wastewater treatment process described above.

The recovered chemicals are reused in spinning dope production process.

Copper and ammonia recovery rates

ZDHC Levels	Ammonia (%)	Copper (%)
Foundational	40	98
Progressive	44	99.5
Aspirational	>44	>99.5

Calculation of ammonia and copper recovery is done by mass balance.

$$\text{Recovery (\%) of ammonia} = \frac{\text{Ammonia recoverd ^ recycled}}{\text{Ammonia recoverd ^ recycled + Ammonia frsh input}} \times 100$$

$$\text{Recovery (\%) of copper} = \frac{\text{Total copper used - Copper fresh input}}{\text{Total copper used}} \times 100$$

Notes:
Since ammonia is recovered as aqueous solution, the total amount of ammonia recovered can be directly determined.

Copper, on the other hand, is recovered as slurry, making it difficult to directly determine the total amount of copper recovered.

However, total used copper can be determined from the total amount of produced spinning dope and its concentration. Therefore, the recovered copper can be determined by subtracting fresh input from the total used copper.

3.5 Acetate

Chemical Recovery

During the production of acetate fibre, acetone solvent (which is non-toxic but can cause serious eye irritation, drowsiness and dizziness) is recovered by closed loop process. Scrubbers can be used to recover acetone during all the production processes even though acetone is a very highly volatile solvent and easily escapes to the environment.

Acetone recovery – treatment methods and control technologies

- By distillation process of acetone-water mixture and re-use of the regenerated solvent in the process.
- Any possible escaped acetone vapours are captured through charcoal filters and recycled and regenerated to the system.

Acetone recovery rates

ZDHC Levels	Acetone (%)
Foundational	93
Progressive	95
Aspirational	98

Calculation of acetone recovery is done by mass balance.

$$\text{Recovery (\%) of acetone} = \frac{\text{(total acetone used) - (fresh acetone input)}}{\text{(total acetone used)}} \times 100$$

Where fresh acetone input = (opening stock as per inventory + purchase) - closing stock

3.6 Sulphate, NMMO, Ammonia, Copper and Acetone Recoveries

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 such technologies available in the market and add to the updates of this document.

The reporting frequency for the average recovery rate shall be based on an annual self-assessment. The reporting cycle shall be for a calendar year (January – December) with the reporting deadline of 31 December each calendar year.

Recovery rates for sulphate, NMMO, ammonia, copper and acetone

ZDHC Levels	Unit	Sulphate recovery *(VSF)	Sulphate recovery *(VFY)	NMMO recovery (lyocell)	Ammonia recovery (cupro)	Copper recovery (cupro)	Acetone recovery (acetate)
Foundational	%	50	60	99.5	40	98	93
Progressive		60	65	99.7	44	99.5	95
Aspirational		70	70	99.8	>44	>99.5	98

3.7 Best Practices for Raw Materials Consumption

The parameters listed below are defined as the amount of raw material or natural resource input required to produce one tonne of fibre or filament, being the raw material average input for viscose, modal fibre or filament, lyocell, cupro and acetate 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.

Recommended raw material consumption for Viscose, Modal (staple fibre or filament), Lyocell, Cupro and Acetate per tonne of fibre[b] or filament[c].

* During Xanthation process, due to the presence of caustic soda, CS_2 added in the process is converted into by-products.
b 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.
c To have correlation of consumption values to recovery rates will require extensive data collection and analysis to make decisions with a science-based approach and will remain a topic for next revision. (For example, caustic consumption to correlate with Sodium Sulphate recovery.)

ZDHC Levels	Unit	Recommended consumption				
		Viscose or Modal Staple Fibre	VFY[e]	Lyocell	Cuproe[f]	Acetate
CS_2	kg/tonne of fibre or filament	80-100	250-300	N/A	N/A	N/A
NMMO (100%)		N/A	N/A	12-30	N/A	N/A
Ammonia		N/A	N/A	N/A	250-500	N/A
Copper Sulphide		N/A	N/A	N/A	5-30	N/A
Zn		2-10	10-20	N/A	N/A	N/A
Spin finish		3-5.3	10-25	3.5.3	12-25	3-5.3
NaOCl[d]		0-70	0-50	0-90	5-40	N/A
Acetone	t/tonne of fibre or filament	N/A	N/A	N/A	N/A	1-4
Acetic acid		N/A	N/A	N/A	N/A	1-4
Acetic Anhydride		N/A	N/A	N/A	N/A	0.5-3
Caustic		0.45-0.6	0.6-0.8	N/A	0.25-0.5	N/A
H_2SO_4		0.65-1.03	0.9-1.1	N/A	1.5-2	0.03-0.09
Pulp		1.010-1.065	1-1.2	1.01-1.065	1-1.1	1.01-1.065

d NaOCl consumption is reported on "as such" basis and not on available chlorine basis.
e CS_2 consumption figures are based on weighted average of different technologies and are limited to standalone VFY sites.
f Consumption calculations for cupro includes linter purification process up to spinning process.

3.8 Environmental Impact: Wastewater Parameters – Load per Tonne of Fibre or Filament

To understand the environmental impact and efficiency of water usage in the production of viscose or modal staple fibres or filament, lyocell and acetate, it is necessary to measure the wastewater parameters listed below in terms of load based values (mg/tonne of fibre produced) rather than only concentration based (mg/l of wastewater discharged). This requires measuring the amount of wastewater discharged from the fibre or filament production process and calculating the load per tonne of fibre or filament by linking the pollutant concentration with the wastewater flow rate in the fibre or filament manufacturing process.

Calculation of the parameters shall be done using the daily average of the month of water flow from the fibre or filament production process considered for the calculation. The concentration (mg/l) used for this calculation shall be taken from the ZDHC MMCF Wastewater Guidelines V2.0 reporting cycles. The month that shall be selected to create the daily average water flow shall be the same as the sampling of the reporting parameter.

The lower the load, the more progressive the facility is.

Calculation of the parameter to be reported in load per tonne of fibre or filament

Parameter load (A)	=	concentration in mg/l (B)	x	water flow per day in m³ (C)
A = any of the parameters from Table 1		B = concentration of the parameter obtained from the testing result done for ZDHC MMCF Wastewater Guidelines V2.0		C= daily average water flow for the month calculated for the month when the sample for the wastewater testing of the concentration parameter was collected

Example of a full reporting year of a manufacturing facility

Reporting Cycle and Year	Parameter	Sampling Month for Reporting ZDHC MMCF Guidelines V2.0	Test Result (Concentration Value)	Water Flow Volume – Daily Average	Load per Tonne of Fibre or Filament (g/tonne)
1-2022	COD-Sea	January 2022	150mg/l	January 2022 = 60 m^3 /day	150 x 60 = 9,000
2-2022	COD-Sea	June 2022	130 mg/l	June 2022 = 60 m^3/day	130 x 60 = 7,800

Table 1 – Wastewater parameters to be assessed in load per tonne of fibre or filament

<table>
<tr><th colspan="17">Wastewater Parameters – Load per Tonne of Fibre or Filament</th></tr>
<tr><th rowspan="4"></th><th rowspan="4">Unit</th><th colspan="15">Limit Values</th></tr>
<tr><th colspan="5">Foundational</th><th colspan="5">Progressive</th><th colspan="5">Aspirational</th></tr>
<tr><th>VSF</th><th>VSF/ Lycocell</th><th>Lyocell</th><th>VFY</th><th>Acetate</th><th>VSF</th><th>VSF/ Lycocell</th><th>Lyocell</th><th>VFY</th><th>Acetate</th><th>VSF</th><th>VSF/ Lycocell</th><th>Lyocell</th><th>VFY</th><th>Acetate</th></tr>
<tr></tr>
<tr><td>COD – to sea</td><td rowspan="4">Load[g] in g/tonne of fibre/ filament</td><td colspan="3" rowspan="3">9000
7200
1800</td><td>24000</td><td>9000</td><td colspan="3">6000</td><td>18000</td><td>6000</td><td colspan="3">3600</td><td>12000</td><td>3600</td></tr>
<tr><td>COD – to other bodies of water</td><td>14400</td><td>7200</td><td colspan="3">6000</td><td>12000</td><td>6000</td><td colspan="3">3600</td><td>9600</td><td>3600</td></tr>
<tr><td>BOD – 5 day</td><td>7200</td><td>1800</td><td colspan="3">900</td><td>4800</td><td>900</td><td colspan="3">300</td><td>2400</td><td>300</td></tr>
<tr><td>Zn</td><td colspan="2">150</td><td>N/A</td><td>600</td><td>150</td><td colspan="2">60</td><td>N/A</td><td>360</td><td>60</td><td colspan="2">30</td><td>N/A</td><td>240</td><td>30</td></tr>
</table>

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

- Fibre production of the time period (in tonnes per month) to calculate the load per tonne of fibre.
- Wastewater test results of the required parameters for the corresponding testing cycle from ZDHC Approved Testing Lab.
- Wastewater flow rate in the month when the sampling was conducted for the testing of the parameters above.
- By-products produced including, but not limited to, Sodium Sulphate, H_2SO_4, Barium Sulphate, etc.

* Cupro being integrated production from linter purification to spinning, the BOD and COD load per tonne of fibre significantly exceed the limit values listed here, so load per tonne has been excluded for cupro.
g Load calculated on a 60m3 per day water flow average.

Chapter 2: ZDHC MMCF Wastewater Guidelines V2.0

This document addresses the expectations for wastewater discharge parameters and limit values (concentration based) related to the production of man-made cellulosic fibres.

It includes the parameters, analytical test methods and sampling procedures for wastewater testing to enable brands and manufacturing facilities to share their test 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 and 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 limit values for conventional and additional parameters, including APEOs, in the wastewater, so that any non-conformities detected can motivate the manufacturer to undertake root-cause analysis and a corrective action plan.

1.0 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
- Viscose filament yarn
- Lyocell
- Cupro
- Acetate

Testing and reporting of the listed parameters in this document by MMCF manufacturers should be conducted in correlation with the ZDHC Wastewater Guidelines V2.1. In case of vertically integrated facilities, where wastewater from the fibre or filament production process is mixed with wastewater from dissolving pulp process, higher limit values can be reported. The reported data will be collected and analysed to help define limit values for such facilities and add dissolving pulp for MMCF to the scope of this document.

Facilities with vertically integrated production that also includes dyeing or finishing processes for yarn or fabrics should apply the most current ZDHC MRSL and test the wastewater for all the ZDHC MRSL parameters listed in the ZDHC Wastewater Guidelines V2.1.

2.0 Requirements

2.1 Minimum Requirements

The minimum requirements of this document are to comply with local legal regulations for wastewater and sludge.

2.2 General Principles for Sampling and Reporting

The general principles for sampling and reporting of this document are directly linked to the latest published version of the ZDHC Wastewater Guidelines V2.1. To learn more click here and for ZDHC Wastewater and Sludge Laboratory Sampling and Analysis Plan V2.1 click here.

Details to be specifically referenced in the ZDHC Wastewater Guidelines V2.1

1. Types of discharge (direct, indirect with or without pre-treatment, zero liquid discharge)
2. Sampling points based on the type of discharge
3. Testing cycles and reporting frequency in the ZDHC Gateway

2.3 Testing Requirements

1. Conventional parameters

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

2. Additional parameters

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

3. Parameters specific to man-made cellulosic fibre or filament production process

These parameters, their limits (foundational, progressive and aspirational), and recommended standard test methods for analysis are defined in Appendix A –Table 1.C (Parameters specific to MMCF production).

Where local legislation 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.

4. Sludge parameters

At a minimum, existing local legal regulations for the treatment and handling of industrial wastewater sludge shall be observed. In addition to existing legal regulations, manufacturing facilities should follow the sludge testing[h] requirements below:

Substance or Substance Group	Unit	Reporting Limit	Test Methods: International / Europe	Test Methods: USA	Test Methods: China	Test Methods: 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[i] – Dry sludge[j]	mg/kg	0.2	DIN 38414-S 17, 2017-01	US EPA 9023	HJ 695:2014 HJ 658:2013 HJ 615:2011	
TOC[k] – %	mg/kg	1000	DIN EN 15936: 2012-11	US EPA 9060		IS 2720 Part 22 IS 3025 Part 69
Heavy metals Zn Cu Ni Pb Cd Hg	mg/kg	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

MMCF facilities can also refer to, and implement, the disposal pathways suited to their facility operations described in the ZDHC Sludge Reference Document V1.0 click here.

Further discussions will be done with MMCF stakeholders to align the sludge testing and disposal requirements for MMCF manufacturers with those outlined in the ZDHC Wastewater Guidelines V2.1 – Tables 4A-4C for the next update to the MMCF Guidelines.

h 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.
i If EOX results are positive then AOX shall be tested.
j Dry sludge: either partially dried (60% to 80% dry sludge) or completely dried(approximately 80% to 90% dry sludge). The percentage of the dry sludge has to be included in the final calculation.
k This parameter should be considered in those facilities where sludge from the MMCF facility is connected to another type of facility.

2.4 Methods for Analysis and Testing

The methods for analysis and 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 EU, the US, China and India.

Other requirements for the methods of analysis and testing of conventional, additional and specific parameters for wastewater, as mentioned in this document, are directly linked to the methods for analysis and testing the conventional parameters for wastewater in the ZDHC Wastewater Guidelines V2.1 click here and ZDHC Wastewater and Sludge Laboratory Sampling and Analysis Plan V2.1 click here.

A. Conventional parameters for wastewater

Standard methods for analysing these parameters are specified in Appendix A – Table 1.A.

B. Additional parameters for wastewater

Standard methods for analysing these parameters are specified in Appendix A – Table 1.B.

C. Parameters specific to the man-made cellulosic fibre or filament production process

Standard methods for analysing these parameters are specified in Appendix A – Table 1.C.

For note taking:

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	US	China	India
		VSF	VSF/ Lycocell	Lyocell	VFY	Cupro	Acetate	VSF	VSF/ Lycocell	Lyocell	VFY	Cupro	Acetate	VSF	VSF/ Lycocell	Lyocell	VFY	Cupro	Acetate				
pH	pH units	6.0 - 9.0																		ISO 10523	USEPA 150.1 SM 4500H+-B	GB/T 6920	IS 3025 (Part 11)
Temperature Difference*	deg 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 (no colour)			8; 5; 3	7;5;3 (no colour)		5;3;2						4;2;1						ISO 7887-B	N/A	N/A	IS 3025 (Part 4)
COD discharge to sea	mg/litre	150		300	200	150		100		200	150	100		60		120	100	60		ISO 15705 (in case of deviating results then ISO 6060)	USEPA 410.4. SM 5220D**	HJ 828	IS 3025 (Part 58)
COD discharge to other bodies of water		120			240	120		100		200	100			60		120	80	60					
BOD 5-day concentration		30			60	30		15			40	15		5			30	5		EN 1899-1 ISO 5815-1	USEPA 405.1, SM 5210B	HJ 505	IS 3035 (Part 44) (BOD5)

* Temperature difference (Δ) OR the difference in temperature of incoming water for manufacturing facility and treated effluent discharged measured onsite by the ZDHC approved wastewater laboratory by sampling at inlet point and effluent discharge point. .The temperature difference parameter is applicable only for direct discharge facilities.

Chapter 2: Appendix A – Parameters and Limit Values

Table 1.A Conventional Parameters Limit Values and Test Methods (continued)

<table>
<tr><th colspan="24">Conventional Wastewater Parameters</th></tr>
<tr><th rowspan="3"></th><th rowspan="3">Unit</th><th colspan="18">Limit Values</th><th colspan="4">Test Methods</th></tr>
<tr><th colspan="6">Foundational</th><th colspan="6">Progressive</th><th colspan="6">Aspirational</th><th rowspan="2">International / Europe</th><th rowspan="2">US</th><th rowspan="2">China</th><th rowspan="2">India</th></tr>
<tr><th>VSF</th><th>VSF/ Lycocell</th><th>Lyocell</th><th>VFY</th><th>Cupro</th><th>Acetate</th><th>VSF</th><th>VSF/ Lycocell</th><th>Lyocell</th><th>VFY</th><th>Cupro</th><th>Acetate</th><th>VSF</th><th>VSF/ Lycocell</th><th>Lyocell</th><th>VFY</th><th>Cupro</th><th>Acetate</th></tr>
<tr><td>Oil and grease</td><td rowspan="8">mg/litre</td><td colspan="3">8</td><td>10</td><td colspan="2">8</td><td colspan="3">5</td><td>8</td><td colspan="2">5</td><td colspan="3">2</td><td>4</td><td colspan="2">2</td><td>ISO 9377-1</td><td>USEPA 1664-B SM 5520-B or C</td><td>HJ 637</td><td>IS 3025 (Part 39) infrared partition method</td></tr>
<tr><td>Total-N</td><td colspan="4">30</td><td>80</td><td>30</td><td colspan="4">25</td><td>70</td><td>25</td><td colspan="6">20</td><td>ISO 29441,11905</td><td>SM 4500N-C 4500N-B</td><td>HJ 636</td><td rowspan="2">IS 3025 (Part 34)</td></tr>
<tr><td>NH4-N</td><td colspan="4">5</td><td>75</td><td>5</td><td colspan="4">3</td><td>65</td><td>3</td><td colspan="4">1</td><td>15</td><td>1</td><td>ISO, 6778, 11732, 5664</td><td>SM 4500NH3-C or D</td><td>HJ 665, HJ 666, HJ 535, HJ 536</td></tr>
<tr><td>TSS</td><td colspan="6">70</td><td colspan="6">50</td><td colspan="6">30</td><td>ISO 11923</td><td>USEPA 160.2, SM 2540D</td><td>GB/T 11901</td><td>IS 3025 (Part 17)</td></tr>
<tr><td>Total-P</td><td colspan="6">3</td><td colspan="6">1</td><td colspan="6">0.5</td><td>ISO 6878, ISO 11885 (ICP-OES), ISO 17294-2 (ICP-MS)</td><td>USEPA 365.4, SM 4500P-J EPA 200.7 (ICP-OES), EPA 200.8 (ICP-MS)</td><td>GB/T 11893 HJ 700 (ICP-MS) HJ 670, HJ 671</td><td>IS 3025 (Part 31) IS 3025 part 65 (ICP-MS)</td></tr>
<tr><td>AOX</td><td colspan="6">5</td><td colspan="6">2</td><td colspan="6">0.2</td><td>ISO 9562</td><td>USEPA 1650</td><td>HJ/T 83-2001</td><td>CPPRI Saharanpur, AOX analyser, ISO 9562</td></tr>
<tr><td>Phenol</td><td colspan="6">1</td><td colspan="6">0.5</td><td colspan="6">0.1</td><td>ISO 14402 ISO 6439 (chloroform extraction)</td><td>SM 5530 B, C&D</td><td>HJ 503</td><td>IS 3025 (Part 43)</td></tr>
</table>

Chapter 2: Appendix A – Parameters and Limit Values

Table 1.B Additional Parameters Limit Values and Test Methods

<table>
<tr><th colspan="24">Additional Wastewater Parameters</th></tr>
<tr><th rowspan="3"></th><th rowspan="3">Unit</th><th colspan="18">Limit Values</th><th colspan="4">Test Methods</th></tr>
<tr><th colspan="6">Foundational</th><th colspan="6">Progressive</th><th colspan="6">Aspirational</th><th rowspan="2">International / Europe</th><th rowspan="2">US</th><th rowspan="2">China</th><th rowspan="2">India</th></tr>
<tr><th>VSF</th><th>VSF/ Lycocell</th><th>Lyocell</th><th>VFY</th><th>Cupro</th><th>Acetate</th><th>VSF</th><th>VSF/ Lycocell</th><th>Lyocell</th><th>VFY</th><th>Cupro</th><th>Acetate</th><th>VSF</th><th>VSF/ Lycocell</th><th>Lyocell</th><th>VFY</th><th>Cupro</th><th>Acetate</th></tr>
<tr><td>Chromium, total</td><td rowspan="8">mg/litre</td><td colspan="6">0.2</td><td colspan="6">0.1</td><td colspan="6">0.05</td><td>ISO 11885, ICP-OES, ISO 17294-2 ICP-MS</td><td rowspan="5">USEPA 200.7. USEPA 200.8.</td><td>GB 7466, HJ700</td><td>IS 3025 (Part 52)</td></tr>
<tr><td>Cadmium</td><td colspan="5">0.1</td><td>N/A</td><td colspan="5">0.05</td><td>N/A</td><td colspan="5">0.01</td><td>N/A</td><td>ISO 11885, ICP-OES, ISO 17294-2 ICP-MS</td><td rowspan="2">GB7475, HJ700</td><td>IS 3025 Part 41, AAS, instrumental method</td></tr>
<tr><td>Copper</td><td colspan="6">1.0</td><td colspan="6">0.5</td><td colspan="6">0.25</td><td>ISO 11885, CP-OES, ISO 17294-2 ICP-MS</td><td>IS 3025 Part 42, AAS, instrumental method</td></tr>
<tr><td>Nickel</td><td colspan="6">0.5</td><td colspan="6">0.2</td><td colspan="6">0.10</td><td>ISO 11885, ICP-OES, ISO 17294-2 ICP-MS</td><td>GB 11907. HJ700</td><td>IS 3025 Part 54, AAS, instrumental Method</td></tr>
<tr><td>Chromium (VI)</td><td colspan="6">0.05</td><td colspan="6">0.005</td><td colspan="6">0.001</td><td>ISO 18412</td><td>GB 7467</td><td>IS 3025 Part 52</td></tr>
<tr><td>Lead</td><td colspan="6">0.1</td><td colspan="6">0.05</td><td colspan="6">0.01</td><td>ISO 11885, ICP-OES, ISO 17294-2 ICP-MS</td><td>USEPA 218.6</td><td>GB7475. HJ700</td><td>IS 3025 Part 47 AAS, instrumental method</td></tr>
<tr><td>Mercury</td><td colspan="6">0.01</td><td colspan="6">0.005</td><td colspan="6">0.001</td><td>ISO 12846 or ISO 17852, ISO 17294-2 (ICP-MS)</td><td>USEPA 245.1, 245.2, EPA 200.8 (ICP-MS)</td><td>HJ 597, HJ 700</td><td>IS 3025 (Part 48) IS 3025 Part 65 (SIM mode)</td></tr>
<tr><td>∑ Hydrocarbons</td><td colspan="2">5.0</td><td>N/A</td><td colspan="2">5.0</td><td>N/A</td><td colspan="2">3.0</td><td>N/A</td><td colspan="2">3.0</td><td>N/A</td><td colspan="2">1.0</td><td>N/A</td><td colspan="2">1.0</td><td>N/A</td><td></td><td>USEPA 1664 B SM 5520-F</td><td></td><td></td></tr>
</table>

Chapter 2: Appendix A – Parameters and Limit Values

Table 1.B Additional Parameters Limit Values and Test Methods (continued)

<table>
<tr><th colspan="24">Additional Wastewater Parameters</th></tr>
<tr><th rowspan="3"></th><th rowspan="3">Unit</th><th colspan="18">Limit Values</th><th colspan="4">Test Methods</th></tr>
<tr><th colspan="6">Foundational</th><th colspan="6">Progressive</th><th colspan="6">Aspirational</th><th rowspan="2">International / Europe</th><th rowspan="2">US</th><th rowspan="2">China</th><th rowspan="2">India</th></tr>
<tr><th>VSF</th><th>VSF/ Lycocell</th><th>Lyocell</th><th>VFY</th><th>Cupro</th><th>Acetate</th><th>VSF</th><th>VSF/ Lycocell</th><th>Lyocell</th><th>VFY</th><th>Cupro</th><th>Acetate</th><th>VSF</th><th>VSF/ Lycocell</th><th>Lyocell</th><th>VFY</th><th>Cupro</th><th>Acetate</th></tr>
<tr><td>APEOs</td><td>ug/litre</td><td colspan="5">5</td><td>N/A</td><td colspan="5">5</td><td>N/A</td><td colspan="5">5.0</td><td>N/A</td><td>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</td><td></td><td></td><td></td></tr>
</table>

Chapter 2: Appendix A – Parameters and Limit Values

Table 1.C Specific Parameters Related to MMCF Production Limit Values and Test Methods

Parameters specific to to the production of MMCF																							
	Unit	Limit Values																		Test Methods			
		Foundational						Progressive						Aspirational						International / Europe	US	China	India
		VSF	VSF/ Lycocell	Lyocell	VFY	Cupro	Acetate	VSF	VSF/ Lycocell	Lyocell	VFY	Cupro	Acetate	VSF	VSF/ Lycocell	Lyocell	VFY	Cupro	Acetate				
Zn	mg/litre	2.5		N/A	5	N/A	2.5	1		N/A	3	N/A	1	0.5		N/A	2	N/A	0.5	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			
Suplhide	mg/litre	2		N/A	5	N/A		1		N/A	3	N/A		0.5		N/A	2	N/A		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			
CS_2	mg/litre	0.5		N/A	0.5	N/A		0.2		N/A	0.2	N/A		0.1		N/A	0.1	N/A		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			

3.0 Testing and reporting by ZDHC Approved Laboratories

The sampling, testing and reporting by ZDHC Approved Laboratories of this document is directly linked to the testing requirements of the ZDHC Wastewater Guidelines V2.1 click here and ZDHC Wastewater and Sludge Laboratory Sampling and Analysis Plan V2.1 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 V2.1. To learn more click here. The list of ZDHC approved wastewater testing labs for ZDHC MMCF Wastewater 2.0 parameters will be made available on our website.

4.0 Data reporting in the ZDHC Gateway – Wastewater Module

The data reporting in the ZDHC Gateway – Wastewater Module should follow the ZDHC Wastewater Guidelines V2.1. To learn more click here.

5.0 Determining Conformance to this Document

Sampling, testing and reporting requirements are the same for manufacturing facilities whether they discharge wastewater directly or indirectly, or have zero liquid discharge (ZLD). 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 in Appendix A Table 1A-1C
  AND
- The applicable ZDHC MRSL wastewater parameter (APEOs) in untreated wastewater[I] to be at concentrations which are at, or below, the reporting limits in Appendix A Table 1B for wastewater

Manufacturing facilities with indirect discharge (with or without) pre-treatment are expected to have:

- All conventional parameters complying with their agreements with the receiving centralised effluent treatment plant (CETP). Achieved the foundational limits for additional parameters (cadmium, chromium [VI], lead, mercury) in Appendix A Table 1.B for wastewater
  AND
- Applicable ZDHC MRSL wastewater parameter (APEOs) in untreated wastewater[I] to be at concentrations that are at, or below, the reporting limits in Appendix A Table 1.B for wastewater[I].

Manufacturing facilities with ZLD are expected to have:

- Applicable ZDHC MRSL wastewater parameter (APEOs) and Σ hydrocarbons in untreated (raw) wastewatera to be at concentrations that are at, or below, the reporting limits in Appendix A Table 1.B for wastewater.

Manufacturing facilities should proactively develop and manage a data driven plan to continuously meet foundational limits and achieve progressive and aspirational limits in the conventional parameters.

I Wastewater discharge types and sample locations can be found in ZDHC Wastewater Guidelines V2.1.

6.0 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 in this document (Appendix A Tables 1.A-1.C) for direct discharge
    - » Exceed the foundational limits of receiving CETPs' requirements, exceed the foundational limits for additional parameters (cadmium, chromium [VI], lead, mercury), and exceeds the MRSL (APEO) parameter reporting limit in this document (Appendix A Table 1.B) for indirect discharge manufacturing facilities
    - » Exceed the MRSL (APEO) parameter reporting limit in this document (Appendix A Table 1.B) for ZLD discharge manufacturing facilities

B. Actions by 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
    - » Checking chemicals used in non-production related areas (for example, APEOs used in cleaning products).
    - » Upload a corrective action plan with defined completion date on the ZDHC Gateway – Wastewater Module
- Manufacturing facilities may resolve non-conformities through a root-cause analysis to prepare and implement a corrective action plan. For example, they could contact clients (brands and 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.

Chapter 3: ZDHC MMCF Air Emissions Guidelines V2.0

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 and filaments. 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 or filament production of MMCF and to minimise any adverse impact in the environment and surrounding communities
- Provide a unified approach to monitoring and testing for manufacturing facilities so that they can systematically and efficiently share emission data with brands they work with and other interested parties
- Increase operational efficiencies by defining a standard cadence for air emission monitoring and reporting requirements that is applicable to all brands and manufacturing facilities adopting this document

1.0 Scope

This document applies to process-related air emissions associated with the production of man-made cellulosic fibres and filaments 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
- Viscose filament yarn
- Lyocell
- Cupro
- Acetate

2.0 Requirements

The basic expectations listed below 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 their 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. To learn more click here.

- Chemical classification is required for input related chemical products that 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, Viscose Filament Yarn, Cupro and Acetate

This document will focus on the following:

- Sulphur emission to air for viscose and modal staple fibres
- Acetone to air for acetate
- Ambient air outside the facility for viscose and modal staple fibres, viscose filament yarn and cupro

Parameters and limit values can be found in Appendix B.

3.0 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 substances of concern are not present above the given concentration.

To streamline efforts, manufacturing facilities are encouraged to align the testing of the parameters listed in this document with the testing required in their legal permit.

3.1 Monitoring

It is imperative that a measurement system, or a continuous sampling or testing procedure, shall be established 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 or Acetone 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 is recommended to follow in principle the Directive 2010/75/EU of the European Parliament on industrial emissions – integrated pollution prevention and control (EU, 2010).

3.2.1 Sulphur or acetone 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 reused as part of the process or sold as a product. Some remaining sulphur can be trapped in the sludge or liquid streams.

Acetone is easily regenerated by the distillation process of acetone-water mixture and the regenerated solvent is reused for the process. Any possible escaped solvent vapours are captured through charcoal filters and are recycled and regenerated back to the system, reducing the loss of acetone solvent to the environment during all the production processes even though acetone is a highly volatile solvent and may easily escape to the environment. The formula for the mass balance of sulphur or acetone can be found in Appendix B, Table 2.B.

3.3 Control Technologies for Sulphur or Acetone Release to Air or Acetone Emission to Air

The viscose/acetate industry uses several technologies to control the emission of sulphur/acetone to air during the manufacturing process. The major technologies in use in the industry are listed in Appendix B, Table 2.B, with the mass balance calculations.

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) and key substances involved in the cupro production process (NH_3) 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.

ZDHC proposes one standardised approach for the measurement of ambient air in the surrounding area of the production facility see Appendix C.

3.5 Test Methods

Where specific testing is required, standardised test methods shall be used:

- 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

- Annual average sampling, testing and reporting of ambient air parameters or assimilation data. The reporting cycle shall start from 1 January and will have a reporting deadline of 31 December of the same calendar year.
- The reporting frequency for the mass balance calculation will be based on an annual verification. The reporting cycle shall start from 1 January and will have a reporting deadline of 31 December of the same calendar 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 retest ambient air as often as necessary to ensure the issue has been resolved.

Chapter 3: Appendix B

Table 2.A Parameters and Limit Values for Production Emissions

Table 2.A Parameters and limit values for production emissions and concentration of CS_2 and H_2S in ambient air related to fibre and filament production of viscose and modal; NH_3 in ambient air related to fibre production of cupro.

ZDHC Levels	Sulphur Emissions to Air Calculated through Mass Balance	CS_2 (Ambient Air Concentration Outside the Facility) Reporting Limit for VSF and VFY	H_2S (Ambient Air Concentration Outside the Facility) Reporting Limit for VSF and VFY	NH_3 (Ambient Air Outside the Facility) Reporting Limit for Cupro
Unit	kg/ton dry VSF (annual basis)	mg/Nm^3	mg/Nm^3	ppm
Foundational	35[m]	0.10[n]	0.10[n,o]	2[q]
Progressive	20[p]			
Aspirational	12[p]			

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

m Based on average between norms assigned to new plants in India and EU Ecolabel criteria for textile products.
n Ministry of environment, forest and climate change of India from 17 January 2018.
o In the next review process of this document the understanding of the possibilities of reaching a lower detection limit will be discussed.
p EU BREF POL recommendation.
q Under Japanese offensive odour control law.

Chapter 3: Appendix B

Table 2.B Mass Balance of Special Sulphur or Acetone Flows

Formula for mass balance

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

Acetone emission to air = I1 - (O1 + O2)

Inputs		**Notes**	**L/S/G**	**Test Method**
I1	CS_2 addition to reactor including fresh input and CS_2 recovered from the process (Churn/Xanthator). Total Acetone		Liquid	As per flowmeter / tank level difference
Recovery / recycle / outputs				
O1	CS_2 / acetone recycled by condensation recovery		Liquid	As per flowmeter / tank level fifference
O2	CS_2 / acetone recycled by activated carbon absorption		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 difference in concentration of CS_2 / H_2S at inlet and 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 equivalent sulphur by calculation. Deduct the supplementary sulphur if fed (any).

Chapter 3: Appendix B

Table 2.B Mass Balance of Special Sulphur or Acetone Flows (continued)

Inputs		Notes	L/S/G	Test Method
Recovery / recycle / outputs (continued)				
O5*	Converted H_2S and CS_2 into SOx by exhaust gas incineration / boiler followed by scrubbing of flue gases by lime to produce gypsum	Flue gas desulphurisation	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 concentration of CS_2 / H_2S at inlet and 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 there is also sulphur in coal. Both get converted to SOx in boiler or incinerator. The SOx are scrubbed by lime to make gypsum. The flue gas from the boiler has some remaining unscrubbed sulphur as SOx. The purity of gypsum varies depending on the flue gas desulphurization process applied.

Explanation about Gypsum on Scrubbing of Flue Gases from CPP Boilers (O5)

O5: (A+B) - (C+D)

Sulphur in: (A + B) where

A: exhaust flow rate from VSF in m^3/hr x equivalent sulphur mg/m^3 (from CS_2 and $H2_S$)

B: % sulphur in coal + quantity of coal burnt in boilers in MT)

Sulphur out: (C+D)

C: SO2 in CPP boiler stack gFlue gas flow rate Nm^3/hr x SO2 mg/Nm^3) x $\frac{32}{64}$

D: (gypsum produced MT) x $\left(\frac{32}{120}\right)$

Reactions:

Dry scrubbing

$CaCO_{3(s)} + SO_{2(g)} \rightarrow CaSO_{3(s)} + CO_{2(g)}$

Wet Scrubbing

$Ca(OH)_{2(s)} + SO_{2(g)} \rightarrow CaSO_{3(s}) + H_2O_{(l)}$

Chapter 3: Appendix C - Measurement of Ambient Air in the Surroundings of the Production Facility

The definition of the assessment area must enable the proper assessment of 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 centre of the emission within radius of a maximum 1 kilometre from the source.

Sampling and testing by an ISO 17025 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
- 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
- World Health Organization – Making Water a Part of Economic Development click here
- ZDHC Roadmap to Zero Programme click here
- Textile Exchange Recycled Claim Standard click here

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