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Faculty of Engineering
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“A comparative study between conventional & new sustainable denim washing”

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**This report submitted in partial fulfilment of the requirements for the
degree of Bachelor of Science in Textile Engineering**

Advance in Wet Processing Technology

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LETTER OF APPROVAL

April 01, 2020

To

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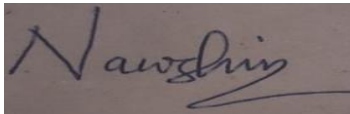
Subject: Approval of Thesis Report of B.Sc. in TE Program.

Dear Sir,

I am just waiting to let you know that this thesis ‘A comparative study between conventional & new sustainable denim washing’ has been prepared bearing ID’s (162-23-4715, 162-23-4709) is completed for final evaluation. The whole report is prepared based on proper assessment and investigation. We were directly involved with our work.

Therefore, it will be highly appreciated if you kindly accept the Thesis report and considered for final evaluation

Your Sincerely.



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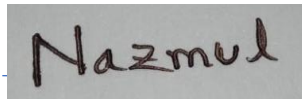
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DECLARATION

We hereby declare that, this project thesis has been done by us under the supervision of **Ms. Nawshin Farzana**, Assistant professor, Department of Textile Engineering, Faculty of Engineering, Daffodil International University. I also declare that, neither this report nor any part of this has been submitted elsewhere for award of any degree.



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DEDICATION

“ To Our dignified parents and teacher may they live long

Abstract

As the faded denim or old look denim is favored by the present youth, washing has become a vital issue for the technologists to change denim attire to satisfy the interest of existing pattern. The primary elements influencing shoppers when choosing articles of clothing are stylish appearance and design. Denim articles of clothing are oppressed in mechanical washing to get explicit appearance and handle. The washing and completing cycles are used with the end goal of design and extraordinary plans are applied for various impacts which are very noteworthy for promoting denim market. Denim also plays a vital role in our economy. The aim of this paper is to find out the effect or changes occurs in physical properties of denim when it is subjected to conventional wash or sustainable wash. To comparing the conventional wash and environment friendly sustainable wash. In the report we try to figure out the changes of Tear strength, Tensile strength, GSM, EPI ,PPI for denim after wash and before wash, and compared them to each other. Weight loss percentage also include in the report. We used denim fabric (75% cotton, 18 % polyester 7 % Viscose). We take a overall score and test report for sustainable wash and conventional wash. The EMI score for both test are measured with the help of lab. In the conventional score we found that Environment medium impact with the score of 63. Here (0-33 low impact), (34-66 medium impact) above 66 is high impact on environment which is not good for environment. In the sustainable wash the EMI score 47. Which is slightly less than conventional wash. We find Sustainable wash chemical, water impact, chemical consumption are less than conventional wash. We try to find out new technology in denim wash, which will be fruitful for this sector and sustainable wash. In the report we try to figure out after wash and before wash comparison in denim. We see that for GSM weight loss percentage is 2.97% and Tear strength weight loss% for warp way is 16.17% and for weft strength loss is 20.46 % . Tensile strength loss % is 24.7%

for warp way and for weft way strength loss % is 14.19%. In this paper with the help of our Teacher we tried to know some upcoming technology which is necessary for denim development, like laser machine, ozone machine effect on denim wash. With the use of these machine denim development will be improved in a sustainable way.

Table of Content

Chapter-1	1
Introduction	1
Chapter-2	5
Literature Review	5
Chapter-3	17
Methodology.....	17
3.1-Material	17
3.1.1-Fabric	17
3.1.2-Chemical and auxiliaries	17
3.2-Method	17
3.2.1-Recipe 1	18
3.2.2-Process Sequence	21
3.2.2.1-Recipe 2	25
3.2.3-Process Sequence	27
3.2.3.1: Recipe 3.....	30
3.2.3.2: Recipe 4.....	33
3.2.3.3-EIM Report.....	36
3.3 Testing method	41
3.3.3- EIM report result analysis	42
3.3.4-Impact on GSM	43
3.3.5 Impact on Tear Strength	43
3.3.6-Impact on Tensile Strength Table	44
3.3.7-Impact on EPI and PPI Table	45
Chapter-4	47
Result and Discussion.....	47
4.1 GSM Changes and Weight Loss Percentage.....	47
4.2 Tear Strength Changes.....	47
4.2.1 Tensile Strength Changes.....	49
4.3 EPI, PPI CHANGES.....	51
4.3.1 Conventional and Sustainable wash and EIM report.....	52
Chapter-5	54
Conclusion.....	54

References	55
Table 1 Fabric Composition.....	17
Table 2 Chemical and Auxiliaries	17
Table 3 Conventional way wash recipe (wet process).....	18
Table 4 Dry Process.....	20
Table 5 Total Time and Water consumption	20
Table 6 Sustainable way wash recipe (wet process).....	25
Table 7 dry process	26
Table 8 Water consumption and total time.....	27
Table 9 Conventional wash recipe-2(wet process)	30
Table 10 Dry process.....	32
Table 11 Total time and water consumption.....	32
Table 12 Sustainable way wash recipe 2(wet process).....	33
Table 13 Dry process.....	35
Table 14 total water consumption and total time	35
Table 15 Recipe 1 and 2differences	42
Table 16 Recipe 3and 4 differences	42
Table 17 EIM report analysis.....	42
Table 18 Impact on GSM.....	43
Table 19 Impact on Tear Strength	43
Table 20 Impact on Tensile Strength	44
Table 21 Impact on EPI and PPI.....	45
Figure 1 EIM Report of Conventional Wash process	36
Figure 2 EIM Report of sustainable wash process	39
Figure 3 GSM changes and Weight loss percentage.....	47
Figure 4 Tear Strength Changes	47
Figure 5 Tensile Strength Changes.....	49
Figure 6 EPI PPI Changes	51
Figure 7 Conventional and sustainable wash and EIM report Analysis graph.....	52

Chapter-1

Introduction

Denim pants address a normal \$60 billion overall market. Style is today inadequate without denim. Denim is a rough cotton twill material, in which the weft goes under two or more twist strings. This twill weaving produces the natural inclining ribbing of the texture, which recognizes denim from cotton duck. It comprises of colored twist and dim weft. The majority of the Denim texture development is either 2/1 or 3/1 development of either left or right gave twill. It is difficult to believe that a comparative denim was at first used in clothing for the pants and overalls worn by diggers on the west coast (US). Different inventive components have added to making denim the style image that it is today fusing gigantic upgrades in turning, weaving, finishing, etc. A champion among the most noteworthy bit of creation of the exquisite denim pants is the washing.

In the material segment article of clothing washing is one of the significant procedures followed in industry. Residue, soil and irresistible materials can be expelled from articles of clothing by mechanical pieces of clothing washing. An assortment of wash strategies can be followed according to form necessity, for improving exceptional look on articles of clothing. Denim washing is tasteful completion given to denim texture to upgrade the interest and to give quality. Dry denim rather than washed denim is a denim texture that isn't washed in the wake of being colored during its creation. A great part of the intrigue of dry denim lies in the way that with time texture will blur in a way like what misleadingly bothered denim endeavors to repeat. With dry denim anyway such blurring is influenced by the body of the individual who wears pants and the exercises of their day by day life. This makes what many tumbled to be progressively regular, one of a kind look than pre bothered denim. It is another innovation by which viewpoint, size, comfort capacity and style of a piece of clothing are changed or altered. This innovation was first showed up in Bangladesh in

1988. Before that washing was done uniquely in Hong Kong and Singapore, for example subsequent to sewing articles of clothing were sent to another country for washing and again brought here back for getting done with, labeling and pressing. Accordingly, additional overhead cost (cargo, washing charge, time utilizations) was attracted

Purpose of denim washing:

- To evacuate estimating materials and to mollify the Garment. Evacuate The Sizing Material delicate the Denim Garments and increase the hand feel of the fabric.
- To change the appearance to make style. Show up alter to new style Denim Garments.
- To make diverse impacts and completes Denim pieces of clothing in the wake of Washing.
- To remove starch, dust and dirt from garments.
- To create new fashion and to introduce a fading effect.
- To satisfy the consumer.
- To increase brightness of garments.
- To make directly wearable after purchase.
- To create different effects and finishes.

Objectives of the report:

The purpose of the Report is to identify the effect of changes due to different washing process. We also try to find out the duties and responsibilities of a service holder as we will go through this Situation soon. Another objective of this Report was to know about the different garments washing process. This Report also includes the different between sustainable wash conventional wash process and changes due to washing on Denim fabric. The specific objectives of the study are describing as follows:

- To know about the different washing process.
- To know about different dry process of garment washing.
- Observe the changes that happens on the sample due to washing.
- Compare the changes, before washing and after washing.
- Compare the damages occurred due to washing.
- To make a compare between conventional denim wash and sustainable denim wash.
- To find the physical appearance and strength of denim wash on different wash.
- To reduce the water consumption.
- To reduce the chemical consumption by sustainable wash.
- To compare a chemical consumption in conventional process and sustainable process.
- To make a sustainable product.
- To know about the physical properties of a denim garments such as PPI, EPI, Weight and fabric behavior.
- To know the types of color fading of garments.

Significant:

Denim sector is developing day by day in our country. Bangladesh exports nearly \$1billion worth of denim products to the European countries in a year. In Europe, one in every three persons wears the Bangladeshi denim items. Indeed, Bangladesh overwhelmed China in denim gracefully to the EU nations as a result of value items at serious costs.

As a fresher textile engineer it is very important to know about the behavior of garments before and after wash. This knowledge will support us some times in planning, sometime in production, some time to full fill the buyer requirement. Denim growth circle in our country is increasing rapidly, so knowledge of denim will be very helpful for our future carrier.

Limitation of Report:

There are some limitations we have faced in report:

- We did not get exact cooperation from the operators due to rapid Covid 19.
- We did not get more investigate report due to third party lab. Which is restricted for outsiders.
- We did not find a lot of information due to not proper use of technique in the industry. In our country sustainable wash is not used usually due to lacking of skill worker and machines.

Scope of the thesis:

- Huge opportunities to do some things in denim washing industry.
- Nowadays the washing demand increasing day by day for production.
- RMG is given so much opportunity for developing new techniques of washing sector

Chapter-2

Literature Review

Rebecca Larsen, thing progression director at House of Gold, the workplace which homes denim plants Blue Diamond, In the Loop, and Jeanious Laundry, said that more spotlight will be put on making a round denim industry. "Sensibility is huge anyway it's lacking. What entirely to happen is we need to close the circle. As opposed to constantly conveying to a consistently expanding degree, we need to make sense of how to reuse what we starting at now have." The example of the 4 Rs — fix, reuse, reuse and decline — will presumably continue rising in the accompanying ten years, according to Larsen. (1)

Tricia Carey, head of overall business headway for denim at Lenzing, said "practicality will never again be an example — it will be embedded in the effortlessly chain (2)

One of our sensibility destinations is that all the cotton in our range should be reused or sensibly sourced by 2020 at the latest: common cotton, reused cotton or cotton sourced through the Better Cotton Initiative (BCI). Furthermore, we are almost there — sensibly sourced cotton addresses 95 % of the cotton we sourced in 2018. We in like manner support screened science and are people in ZDHC. (3)

H&M rank all denim as demonstrated by Jean logia's device EIM (Environmental Impact Measurement), "30.8% of our denim things have achieved a green level EIM which suggests they used a restriction of 35 liters of water for each piece of clothing during the treatment structures." (4)

Giving new life to old jeans is something MUD Jeans and Recover, collaborated on two or three years back also, changing old MUD pants into new MUD pants. They've pushed improvement

higher than any time in recent memory by endeavoring to fabricate the degree of reused cotton that can be used to 40% (5)

Past assessment coordinated by Circle Economy and G-Star RAW exhibited that by consolidating 12% reused content in some jeans, water utilize decreased by 9.8%, imperativeness usage by 4.2% and the CO2 impression by 3.8%. (6)

Wrangler starting at now drives the course in water saving and improvement , making it a point of convergence of their game plan and assessment. "Water use and wastewater are likely the best viability challenges in denim creating, which is the explanation we're satisfied to have brought foam shaded denim to our industry," says Atwood. "We're invigorated for various brands to copy our model, and in every way that really matters take out the water expected to shading Levis blue."(7)

Theoretical background

The world denim originates from the name of an investigation texture called serge, initially made in Nimes, France, by the Andre family. Initially called Serge de Nimes, the name was before long abbreviated to denim. Denim has been utilized in America since the late eighteenth century. Denim at first picked up fame in 1873 when Jacob W. Davis, a tailor from Nevada, fabricated the principal pair of bolt fortified denim pants. His idea for making strengthened pants was propelled when a client mentioned some tough and solid jeans for her better half to cleave wood. Levi Strauss, a businessperson, and Jacob Davis, a tailor, provided excavators with denim pants that were produced using strong material and fortified with bolts at the spots where jeans would in general tear which delayed existence of jeans. This denoted the start of the legend of pants and brand Levi Strauss is still enormously effective today.

Denim was first utilized for garments worn by laborers as a result of its high strength. At that point it turned out to be broadly mainstream during the 1930s when Hollywood began making cowpoke motion pictures in which entertainers wore pants. With the start of the World War 2, creation of the pants drops however world meet denim when American fighters began wearing them when they were on the leave. At the point when the war finished, different organizations that made denim began seeming like Wrangler and Lee.

Jean and denim stayed two totally different textures, and were utilized for various sorts of apparel. Denim was utilized chiefly for laborers garments and jean for lighter garments that didn't have such high toughness necessities. By the late nineteenth century, weavers in America were making twills in a similar manner as the European denim, adjusting to the more promptly accessible and privately

created cotton strands. The material had gained notoriety for being solid and not destroying rapidly, regardless of numerous washes.

Youngsters began sporting denim during the 1950s as a mean of insubordination. Denim was the generally shaded blue with indigo color to make blue "pants", however "jean" at that point signified an alternate lighter cotton material; the contemporary utilization of jean originates from the French word for Genoa, Italy, where the primary denim pants were made. Other than indigo coloring, denim can be hued with sulfur coloring which is utilized for coloring of denim in hues other than indigo.

Sustainability in textile:

sustainability is accomplished when all individuals on Earth can live well without trading off the personal satisfaction for people in the future"— Rolf Jucker. Each human has his own options or inclinations and might want to have an agreeable existence. Be that as it may, this solace ought not be accomplished at the expense of other's inconvenience or sufferings. The idea of supportable improvement demands protection of assets for the people in the future.

Nature, earth, biodiversity, and biological systems should be supported for agreeable life at the present just as what's to come. Material Industry is a quickly developing industry in the twenty-first century both in quite a while of creation volume and business, and consequently, the business' effect is gigantic on Likewise, material industry is a parched industry with enormous purchaser of water, an asset that is turning out to be scant step by step. The material business is arraigned to be one among the most contaminating enterprises, and subsequently, it gets required to receive reasonable practices so as to save the Mother Nature. At present, the vast majority of the business rehearses are adjusted or changed so as to accomplish maintainability, and for these, measures are basic.

Sustainable practices in material industry incorporate utilizing less measures of water, risky synthetic substances, pesticides, and composts; receiving eco-accommodating creation forms; utilizing less vitality for creation forms; and presenting 3 Rs—Reduce, Reuse, and Recycle. Society is additionally picking up mindfulness on green commercialization and searching for eco products. Sustainable principles and endorsements are worried about the wellbeing of the customer, the producer, the general public, and nature on the loose.

What is Sustainable denim wash:

Sustainability is the preservation of environment and environmental materials using some special method while working or manufacturing goods. Here for denim washing process it needs huge water for the denim washing treatment and also other some essential things, like electricity, gas, heat is also required for denim washing process. The method which way we can reduce the use of raw materials for manufacturing that is the way called sustainability. For denim wash, we need to reduce the use of water, electricity, gas, heat for denim washing and finishing and this way we can make sustainable denim wash process.

Firstly, for sustainability it needs to reduce the timing for the washing process using special chemical for application which can quickly work and give the expected outcome sooner.

Like (Conventional way to sustainable way)

- 1) Good quality enzyme can give better result for brining abrasion in less timing.
- 2) Wash cycle can be reduced keeping the quality same of the final garments using technical literature of denim wash process. This way time will be shorten and less timing means, less electricity consumption

- 3) Using of Potassium Permanganate can be replaced by Laser burning which can save our environment as well as potash is also very harmful for human health.
- 4) The abrasion can be made on some dark color garments using laser burning which having less abrasion on the garments surface.
- 5) We can shorten the process of hand sanding/sand blasting and make the whisker & Sand blasting using Laser burning. This way we will save the electricity as well as manual work will be decreased and also production will be increased with quality standard outcome.
- 6) We can re-use the potash solution while towel wash/ acid wash/ acid rain wash garments washing. And this way we do not need to drain the potash solution directly to the ground which way we can save the environment.
- 7) Heat should be utilized & reused using technical literature of denim wash8) Heat recovery system from the gas generator can be setup to utilize the heat from gas generator. Also some steps of the wash can be done using this limit heat of 40-45 degree. (Steps: De-Size & Enzyme, etc.)
- 9) Some special type chemical can be used for neutralize & activating the Potash & Bleach which will affect less than the conventional chemical

Machine used in washing plant :

- Sample washing machine (Horizontal or vertical)
- Grinding machine
- Washing machine (Side loading)
- Tagging machine
- Washing machine (Front loading)
- Steam chamber for crinkle
- Hydro extractor machine
- Sand blasting Gun
- Dryer machine (Steam or gas)
- Sand blasting chamber
- Chemical mixture machine • Spray gun and dummy
- Industrial oven (Gas or electric)
- Boiler
- Laser draw
- Generator

Types of chemical used in washing plant:

• Enzyme • Micro emulsion silicon • Detergent • Salt (sodium chloride) • Acetic acid • Buffer • Anti back staining agent • Hydrogen peroxide • Bleaching powder • Stabilizer • Sodium hyposulfite • Fixing agent • Caustic soda • Catanizer • Soda ash • Optical brightener • Sodium bicarbonate • Resin • Potassium permanganate • Sodium metabisulphite • Cationic / Nonionic flax softener • Desizing agent.

The function of chemicals used in washing plant:

Enzyme: enzyme is mainly used in denim washing for getting fading effect on garments

Detergent: Detergent is used in desizing process. Detergent help to remove the size material from the warp yarn of denim garments

Acetic Acid: Acetic Acid is used to control the pH value in wash bath and neutralize the garments from alkaline condition

Anti-back staining agents: It helps to not attached the removed dye on the fabric surface during de sizing and enzyme wash process. Hence, it reduces the fading effect

Bleaching Powder: Bleaching powder is used to remove the color from denim garments in bleach wash process, it helps to get different shade like dark wash, mid wash, light wash

Sodium Hypo sulphite: Sodium hyposulphite is neutralizing agent used to neutralize the garments from chlorine bleach.

Caustic Soda: Caustic soda is used in cleaning process it helps to remove little amount of color from garments compare as bleach powder. It is work as old looking affect come rapidly on garments.

Soda Ash: In desize process soda ash used for getting reddish tone. It also use in cleaning process, it has a cleaning power and help color fading effect of garment.

Sodium Bicarbonate: Sodium bicarbonate is used in denim washing in the bleach bath with bleach powder for Denim Light shade. It used because easily color out with in shot time. Production increase and costing is low.

Potassium Permanganate: Potassium permanganate is used as spray on the surface of garments for color out. Also used in acid wash with pumice stone for color out from the garments.

Flax Softener (Cationic, nonionic): Softener is used to make the garments surface feel both silky and soft and also provides excellent lubricating properties.

Micro Emulsion Silicon: Used to create clothes surface soft. Its offers higher hand feel than flax softener. It offers cloth to glorious lubricating properties, dimensional stability, tear resistance and cloth to be cut and seamed a lot of simply permits and rising wear and easy-care properties.

Sodium Chloride (Salt): Its only used in tinting process of denim wash it helps to exhaust dye in to the fiber

Buffer: Buffer is used in washing plant to control pH of enzyme bath, softener bath, de-sizing bath.

Hydrogen Peroxide: In alkali medium, hydrogen peroxide breaks up and gives some perhydroxylion, which discolouring materials and as a result fading affect is developed. It also neutralized the garment from alkali condition.

Stabilizer: Stabilizer used to resist of deformation Hydrogen peroxide and peroxide works in bath smoothly.

Optical Brightness: Red brightener. b) Blue brightener, this two brightener is used in washing plant

1. optical brightener is used for increase the brightness of garments.

Resin: Resin is used for creation 2d or 3d effect , it gives semi-permanent creases in denim and other cellulose fabrics. It is used also cotton and polyester fabric. Fabric retains soft handle after washing.

Sodium Metabisulfite: Sodium metabisulphite is used in to neutralized the garments after bleaching process and from potassium permanganate.

De-sizing Agent: De-sizing agent is used to remove mainly size material, waxes, dust, minerals & unfixed indigo dye from denim, twills, poplin & canvas fabrics etc.

Disadvantages and Environmental pollution facts of classical denim washing methods :

We should be honest: denim is a terribly filthy industry. To make pants resembles to make sausages. That's why it's normally done in lacking nations where the natural guidelines are not outlined plainly. In spite of the natural realities denim despite everything keeps to be developing piece of the design market. Particularly significant is to look with the angle that denim washing is one of the most condition dirtying advancements. Realities were considered around 2010. Indeed, even the usually utilized innovations are all the more ecologically well disposed these days, if present day less dirtying synthetic concoctions are utilized as together inside and out with pertinent sewage plants

– detriments like high vitality and water utilization, multi part creation procedure and bunches of waste help endeavors of denim experts to design new, greater condition benevolent ones. In any case; greater levels of popularity cause more significant expenses of the items, what is firmly identified with notable horrible work states of the denim business laborers around the globe. There is an away from between the marvel of quick design and modest garments, and low item costs.

Some Sustainable denim processing technology:

Ozone fading of denim:

The fabric is bleached in a washing machine with dissolved ozone in water for denim washing by ozone. Denim clothing may also be bleached or stained in a closed room, using ozone gas. Some of the techno-environmental benefits of ozone-based denim processing are: (1) minimal loss of strength of the fabric, (2) a straightforward process, (3) low water and chemical involvement, and (4) process economy. The method is simple and environmentally friendly, because the ozonized water can be easily laundered deionized with the application of UV radiation. Ozone work as a bleaching agent and sterilizing agent Ozone air (gaseous petrol) commonly goes about as a gentle fading specialist just as a disinfecting operator. It will change shading blue to white. In this method of denim washing, the machine takes air from the environment, channels it and isolates it into its basic segments. Oxygen (O₂) is therefore cleansed and improved and the O₂ atom is changed into an O₃ particle with high voltage, producing ozone gas. The ozone got is infused into the tumbler that washes the pants. It normally ages the denim, which brightens as though sun faded. Toward the finish of the dying cycle, the ozone is sucked from the drum and re-blended in with climatic parts to become oxygen before being discharged into the air.

Plasma technology:

Laser and plasma advances have demonstrated a potential for making diverse surface impacts on texture without utilizing a lot of water and synthetic substances. Synthetically, a responsive plasma release has been utilized in different enterprises to alter the particular surface properties of the materials; in the previous two decades, it has likewise been plentifully applied in material handling. Washing of denim pieces of clothing is a contaminating action in the material business; be that as it may, if plasma is applied to denim pants, it limits or inside and out maintains a strategic distance from the utilization of water. Up until now, plasma introduction has fundamentally been utilized to blur indigo and sulfur-colored denim articles of clothing. Generally, it is the oxygen cold plasma that has been gone after for de-sizing and shading blurring of denim material. Washed denim is an attractive look in an article of clothing that is for the most part tedious and polluting process.

Laser technologies in denim washing:

In laser wash, there is no utilization of water, stones or sand to wash the pants. The wash is finished utilizing laser which goes over the pants and consumes the wash into them. The procedure is speedy and the washes look stunning. This sans water innovation can give a lot of needed 'upset' or 'vintage' look to the denim. laser is applied in denim or pants pieces of clothing rather than Potassium Permanganate (PP) splash. Laser is a vitality source whose force and force can be accurately controlled. It is delivered by mix of CO₂ +DC current. The laser is applied on the texture as per the require power. There are three sections in laser m/c-PC part, siler part (synthetic segment) and laser part. The work bed might be of honeycomb structure or metal braces or metal bars (likewise containing little openings)

Chapter-3 Methodology

3.1-Material: Denim Garments was collected from CCL-3 apparel(ha-meem group)

3.1.1-Fabric Composition

Cotton	75%
Polyester	18%
Viscose	7%

Table 1 Fabric Composition

3.1.2-Chemical and auxiliaries:

SL	Chemical name	Brand name	Function
1	Lycra Protector	EPQ(700)	eliminates the problem of shrinkage and breakage of stress yarn.
2	Detergent	Biode	Remove size material
3	Powder enzyme	Valu max	Used for fading effect
4	Bleaching agent	KCI Bleach	Remove color from denim garments
5	Sodium metabisulfite	S-Meta	Neutral the garment,after bleaching neutral must be needed
6	salt	Glauber salt	Increase dye affinity toward fabric
7	Softener	Fdc softener	Increase Handfeel
	Potassium permanganate		used in washing plant for colour out from the denim garments

Table 2 Chemical and Auxiliaries

3.2-Method:

3.2.1-Recipe 1:

Table 3 Conventional way wash recipe (wet process)

Conventional way wash recipe							
Wet process							
Serial	Step	Chemical	Weight	Water label	Temperature	Running time	Remark
1	De-size	EPQ(700)	80 gm	80L	50°C	10min	drain
		Bio-de	80gm				
	Rinse 1			80L	RT	1-2min	drain
	Rinse 2			80L	RT	1-2min	drain
2	Enzyme	Neutral Enzyme	80 gm	80L	RT	25min	drain
		EPQ(700)	80 gm				
	Rinse 1			80L	RT	1-2min	drain
	Rinse 2			80L	RT	1-2min	drain
3	Bleach 1 st time	Calcium Hypochlorite	10gm/L	80L	50°C	2-3min	Check
	Bleach 1st time	Calcium Hypochlorite	10gm/L	80L	50°C	2-3min	Check and drain

	Rinse 1			80L	RT	1-2min	drain
	Rinse 2			80L	RT	1-2min	drain
4	Neutral	Sodium metabisulfite	200gm	80L	RT	5min	drain
	Rinse 1			80L	RT	1-2min	drain
	Rinse 2			80L	RT	1-2min	drain
	Hydro extractor					5min	
	Dryer					40min	
5	PP Neutral	Sodium metabisulfite	200gm	80L	RT	5min	drain
	Rinse 1			80L	RT	1-2min	drain
	Rinse 2			80L	RT	1-2min	drain
6	Tint	Brown(direct dye)	5gm	80L	40°C	2min	drain
		Glauber Salt	100 gm				
	Rinse 1			80L	RT	1-2min	drain
	Rinse 2			80L	RT	1-2min	drain
7	Softener	FDC Softener	80gm	80L	Rt	5min	

	Hydro extractor					5min	
	Dryer					40min	

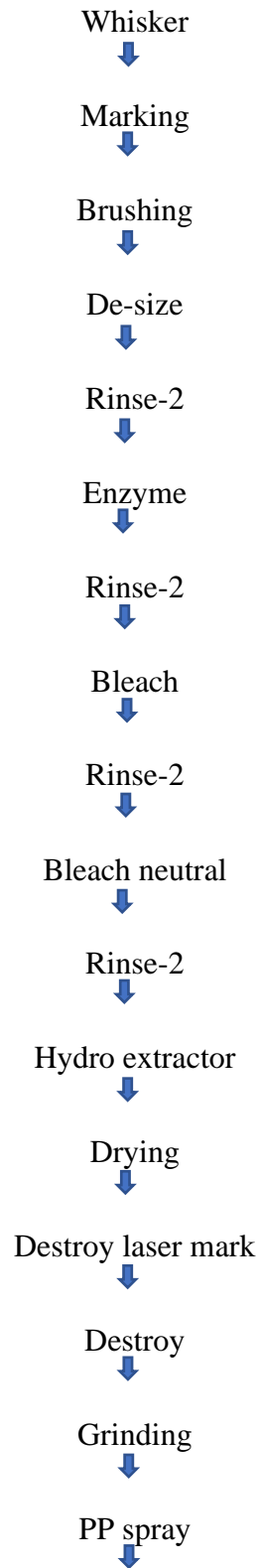
Dry process		
SL	Step	Time
1	Whisker	12min
2	Marking	1min
3	brushing	8min
4	PP spray	8min
5	Destroy laser mark	4min
6	destroy	10min
7	grinding	6min

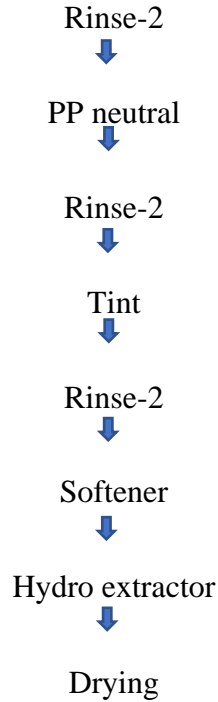
Table 4 Dry Process

Total Water consumption	1600L
Total time Taken	220 min

Table 5 Total Time and Water consumption

3.2.2-Process Sequence:





De-sizing Treatment:

Denim was de-sized using de-sizing agent. And it's a mandatory pre-treatment before denim washing. De-sizing agent, detergent, anti back staining agent, Lycra protector and material to liquor ratio 1:8 was used in a small scale front loading industrial washing machine. This treatment was carried out at temperature 50°C for 10min. After completing the predetermined time the liquor was dropped out. Then treated denim pant were rinsed two times.

Enzyme:

At first we load the denim into the washing machine and load with water maintain the liquor ratio 1:8 then we put the pumice stone into the machine and added powder enzyme, anti back staining agent and Lycra protector and run the machine for 35 minutes, this treatment held in room temperature so we don't need to fix the temperature on this. After that it rinsed two times.

Bleaching:

At first we load the denim into the washing machine and load with water maintain the liquor ratio 1:8 then we put bleaching agent into the machine and run the machine for 9 minutes, this treatment held at 50°C temperature . After that it rinsed two times.

Neutral:

At first load the denim into the washing machine and load with water maintain the liquor ratio 1:8 then we put sodium metabisulfite and run the machine for 5 minutes, this treatment held at 40°C temperature. After that it rinsed two times

PP neutral:

At first load the denim into the washing machine and load with water maintain the liquor ratio 1:8 then we put sodium metabisulfite and run the machine for 5 minutes, this treatment held at 40°C temperature. After that it rinsed two times

Tint:

Tint means dyeing, sometimes tint is used based on shade , at first load the denim into washing machine and load with water maintain liquor ratio 1:8 then we put direct dye and salt and run the machine for 5minute at 60°C. After that it rinsed two times

Softener:

At first load the denim into the washing machine and load with water maintain the liquor ratio 1:8 then we put citric acid, non -ionic or silicon softener and run the machine for 5 minutes, this treatment held at 25°C temperature

Hydro Extracting and Drying Processes

After completing the wash we have 4denim in hour hand. After washing we had to dry for our next process. washed denim was squeezed to a wet pick-up of 70% at 80 rpm for 5min in hydro-extractor then dried at 75°C for 35-40 min in a steam drier (Opti-Dry, Roaches International Limited, England). Samples were tested after Drying

3.2.2.1-Recipe 2

Table 6 Sustainable way wash recipe (wet process)

Sustainable way wash recipe							
Wet process							
Serial	Step	Chemical	Weight	Water label	Temperature	Running time	Remark
1	De-size	EPQ(700)	100 gm	100L	50°C	10min	Next dozing
		A.NTM	100				
2	Enzyme	Neutral Enzyme	80 gm		RT	25min	Check and next dozing
		EPQ(700)	60gm				
3	Bleach 1 st time	Calcium Hypochlorite	10gm/L		50°C	3-4min	Check
	Bleach 1st time	Calcium Hypochlorite	10gm/L		50°C	2-3min	Check and next dozing
4	Neutral	Sodium metabisulfite	200gm		RT	5min	Next dozing
		A.NTM	60gm				
6	Tint	Brown(direct dye)	5gm		40°C	2min	Check and drain
		Glauber Salt	100 gm				

	Rinse 1			80L	RT	1-2min	drain
	Rinse 2			80L	RT	1-2min	drain
4	PP Neutral	Sodium metabisulfite	200gm	80L	RT	5min	drain
	Rinse 1			80L	RT	1-2min	drain
7	Softener	FDC Softener	80gm	80L	Rt	5min	
	Hydro extractor					5min	
	Dryer					40min	

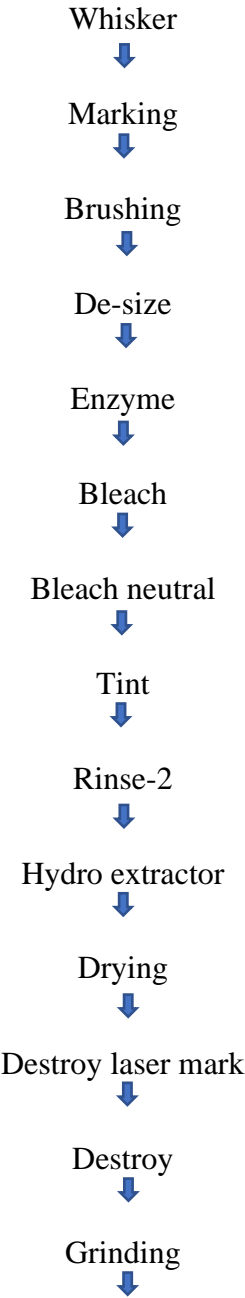
Dry process		
SL	Step	Time
1	Whisker	12min
2	Marking	1min
3	brushing	8min
4	PP spray	8min
5	Destroy laser mark	4min
6	destroy	10min
7	grinding	6min

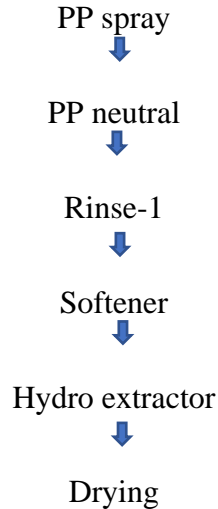
Table 7 dry process

Total Water consumption	500L(1100L saved)
Total time Taken	164min(56min saved)

Table 8 Water consumption and total time

3.2.3-Process Sequence:





De sizing Treatment

Denim was de sized using de sizing agent., anti back staining agent, Lycra protector and material to liquor ratio 1:8 was used in a small scale front loading industrial washing machine. This treatment was carried out at temperature 40-45°C for 10min. After completing the predetermined time the liquor was not dropped out.

Enzyme:

we added powder enzyme, anti back staining agent and Lycra protector and run the machine for 25 minutes, this treatment held in room temperature so we don't need to fix the temperature on this. After completing the predetermined time the liquor was not dropped out.

Bleaching:

we put bleaching agent into the machine and run the machine 3 minutes and then check ,then run more 2 min ,then garments check and loading for next process, this treatment held at 50°C temperature

Neutral:

we put sodium metabisulfite and run the machine for 5 minutes, this treatment held at 40°C temperature.

Tint:

Tint means dyeing, sometimes tint is used based on shade , at first load the denim into washing machine and load with water maintain liquor ratio 1:8 then we put direct dye and salt and run the machine for 5minute at 60°C. After that it rinsed two times

PP neutral:

At first load the denim into the washing machine and load with water maintain the liquor ratio 1:8 then we put sodium metabisulfite and run the machine for 5 minutes, this treatment held at 40°C temperature. After that it rinsed two times

softener:

At first load the denim into the washing machine and load with water maintain the liquor ratio 1:8 then we put citric acid ,non ionic softener or silicon softener and run the machine for 5 minutes, this treatment held at 25°C temperature

Hydro Extracting and Drying Processes

After completing the wash we have 4denim in hour hand. After washing we had to dry for our next process. washed denim was squeezed to a wet pick-up of 70% at 80 rpm for 5min in hydro-extractor then dried at 75°C for 35-40 min in a steam drier (Opti-Dry, Roaches International Limited, England). Samples were tested after Drying

3.2.3.1: Recipe 3

Table 9 Conventional wash recipe-2(wet process)

Conventional way wash recipe							
Wet process							
Serial	Step	Chemical	Weight	Water label	Temperature	Running time	Remark
1	De size	Anti back staining	80 gm	80L	40°C	10min	Drain
		Denimcol wash RGN	80				
	Rinse 1			80L	RT	1-2min	drain
	Rinse 1			80L	RT	1-2min	drain
2	Enzyme	Enzyme(neutral cellulase)	80 gm	80L	RT	25min	Check
		Denimcol wash RGN	80 gm				
		Anti back staining	80gm				
		Enzyme(neutral cellulase)	80 gm	80L	RT	5min	Check and

							next dozing
	Rinse 1			80L	RT	1-2min	drain
	Rinse 2			80L	RT	1-2min	drain
3	Bleaching	Soda ash	800gm	80L	50°C	9min	Check and drain
		Calcium Hypochlorite	80gm				
	Rinse 1			80L	RT	1-2min	drain
	Rinse 2			80L	RT	1-2min	drain
4	Neutral	Sodium metabisulfite	80gm	80L	RT	5min	drain
	Rinse 1			80L	RT	1-2min	drain
	Rinse 2			80L	RT	1-2min	drain
	Hydro extractor					5min	
	Dryer					35min	
5	PP Neutral	Sodium metabisulfite	200gm	80L	RT	5min	drain
	Rinse 1			80L	RT	1-2min	drain

	Rinse 2			80L	RT	1-2min	drain
7	Softener	FDC Softener	80gm	80L	Rt	5	drain
	Hydro extractor					5min	
	Dryer					30min	

Dry process		
SL	Step	Time
1	Whisker	10min
2	Marking	1min
3	brushing	6min
4	PP spray	8min
5	Destroy laser mark	4min
6	destroy	8min
7	grinding	5min

Table 10 Dry process

Total Water consumption	1360L
Total time Taken	201 min

Table 11 Total time and water consumption

3.2.3.2: Recipe 4

Table 12 Sustainable way wash recipe 2(wet process)

Sustainable way wash recipe							
Wet process							
Serial	Step	Chemical	Weight	Water label	Temperature	Running time	Remark
1	De size	Anti back staining	100 gm	100L	40°C	10min	Next dozing
		Denimcol wash RGN	80gm				
2	Enzyme	Enzyme(neutral cellulase)	80 gm		RT	25min	Check
		Denimcol wash RGN	60 gm				
		Anti back staining	50gm				
		Enzyme(neutral cellulase)	80 gm		RT	5min	Check and next dozing

3	Bleaching	Soda ash	800gm		50°C	9min	Check and drain
		Calcium Hypochlorite	80gm				
	Rinse 1			80L	RT	1-2min	drain
	Rinse 2			80L	RT	1-2min	drain
4	Neutral	Sodium metabisulfite	80gm	80L	RT	5min	drain
	Rinse 1			80L	RT	1-2min	drain
	Rinse 2			80L	RT	1-2min	drain
	Hydro extractor					5min	
	Dryer					36min	
5	PP Neutral	Sodium metabisulfite	200gm	80L	RT	5min	drain
	Rinse 1			80L	RT	1-2min	drain
	Rinse 2			80L	RT	1-2min	drain
7	Softener	FDC Softener	80gm	80L	Rt	5	drain
	Hydro extractor					5min	

	Dryer					30min	
--	-------	--	--	--	--	-------	--

Dry process		
SL	Step	Time
1	Whiskering	10min
2	Marking	1min
3	brushing	6min
4	PP spray	8min
5	Destroy laser mark	4min
6	destroy	8min
7	grinding	5min

Table 13 Dry process

Total Water consumption	820L(540L saved)
Total time Taken	194 min(7min saved)

Table 14 total water consumption and total time

3.2.3.3-EIM Report

Figure 1EIM Report of Conventional Wash process

Report Process: Asmara #355D (Conventional) Sample

STEPS

1 - Whiskers	2 - Hand Sand	3 - Desize	4 - Rinse
Manual operation	Manual operation	Washing machine (Horizontal)	Washing machine (Horizontal)
Time: 3 min	Time: 2 min	Time: 10 min Temperature: 50°C LR 1:8 Gradient 4 °C/min Recycled water? No	Time: 2 min Temperature: 25°C LR 1:8 Gradient 4 °C/min Recycled water? No
		Chemicals Stones (Pumice) 1 kg / kg Anti-back staining 2 g / L Base Deterpal EP-Q New 1 g / L	

5 - Rinse	6 - Enzyme	7 - Rinse	8 - Rinse
Washing machine (Horizontal)	Washing machine (Horizontal)	Washing machine (Horizontal)	Washing machine (Horizontal)
Time: 2 min Temperature: 25°C LR 1:8 Gradient 4 °C/min Recycled water? No	Time: 50 min Temperature: 45°C LR 1:6 Gradient 4 °C/min Recycled water? No	Time: 2 min Temperature: 25°C LR 1:8 Gradient 4 °C/min Recycled water? No	Time: 2 min Temperature: 25°C LR 1:8 Gradient 4 °C/min Recycled water? No
	Chemicals Enzyme (Neutral cellulase) 2% owg Stones (Pumice) 1 kg / kg Anti-back staining 2 g / L Base Deterpal EP-Q New 1 g / L		

9 - Stone Out	10 - Bleach	11 - Rinse	12 - Bleach
Manual operation (minutes)	Washing machine (Horizontal)	Washing machine (Horizontal)	Washing machine (Horizontal)
Time: 5 min	Time: 20 min Temperature: 50°C LR 1:10 Gradient 4 °C/min Recycled water? No	Time: 2 min Temperature: 25°C LR 1:8 Gradient 4 °C/min Recycled water? No	Time: 15 min Temperature: 50°C LR 1:10 Gradient 4 °C/min Recycled water? No
	Chemicals Calcium Hypochlorite 10 g / L		Chemicals Calcium Hypochlorite 8 g / L

13 - Rinse	14 - Rinse	15 - Neutral	16 - Rinse
Washing machine (Horizontal)	Washing machine (Horizontal)	Washing machine (Horizontal)	Washing machine (Horizontal)
Time: 2 min Temperature: 25°C LR 1:8 Gradient 5 °C/min Recycled water? No	Time: 2 min Temperature: 25°C LR 1:8 Gradient 4 °C/min Recycled water? No	Time: 5 min Temperature: 40°C LR 1:6 Gradient 4 °C/min Recycled water? No	Time: 2 min Temperature: 25°C LR 1:8 Gradient 4 °C/min Recycled water? No
		Chemicals Sodium Metabisulfite 1 g / L	

17 - Rinse	18 - Extract	19 - Tumbler & Dryer	20 - Destroy Laser Mark
Washing machine (Horizontal)	Hydro Extractor	Tumbler dryer	Laser (Cleanlogix Flexi HS)
Time: 2 min Temperature: 25°C LR 1:8 Gradient 4 °C/min Recycled water? No	Time: 3 min	Time: 30 min Temperature: 60°C	Time: 60 s

21 - Destroy Opening	22 - P.P Spray	23 - Neutral	24 - Rinse
Manual operation	Manual operation	Washing machine (Horizontal)	Washing machine (Horizontal)
Time: 3 min	Time: 2 min	Time: 5 min Temperature: 45°C LR 1:8 Gradient 4 °C/min Recycled water? No	Time: 2 min Temperature: 25°C LR 1:8 Gradient 4 °C/min Recycled water? No
	Chemicals Potassium Permanganate 10 g / L	Chemicals Sodium Metabisulfite 1 g / L	

25 - Cleaning Washing machine (Horizontal) Time: 10 min Temperature: 50°C LR 1:8 Gradient 4 °C/min Recycled water? No Chemicals Hydrogen Peroxide 3 g / L Anti-back staining 2 g / L Base Deterpal EP-Q New 1 g / L	26 - Rinse Washing machine (Horizontal) Time: 2 min Temperature: 25°C LR 1:8 Gradient 4 °C/min Recycled water? No	27 - Rinse Washing machine (Horizontal) Time: 2 min Temperature: 25°C LR 1:8 Gradient 4 °C/min Recycled water? No	28 - Tint Washing machine (Horizontal) Time: 5 min Temperature: 45°C LR 1:8 Gradient 4 °C/min Recycled water? No Chemicals Direct dyes 0 % owg
---	--	--	--

29 - Softener Washing machine (Horizontal) Time: 5 min Temperature: 25°C LR 1:6 Gradient 4 °C/min Recycled water? No Chemicals Acid - Citric acid 0.5 g / L Belfasin OZK TR 1 g / L	30 - Extract Hydro Extractor Time: 4 min	31 - Tumbler & Dryer Tumbler dryer Time: 30 min Temperature: 60°C
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ENVIRONMENTAL INFORMATION

GARMENT WEIGHT (KG): 0.4

Process name: Asmara Conventional	Environmental Threshold: EIM FEBRUARY 2020	Process time: 4hr 10min		
63 Medium Impact	Calculated Impact			
	Water Impact (l/garment) 66.4	Energy Impact (kWh/garment) 1.61	Chemical Impact (garment) 57	Worker Impact (garment) 60.5
63 Medium Impact	Effective Impact			
	Water Impact (l/garment) 66.4	Energy Impact (kWh/garment) 1.61	Chemical Impact (garment) 57	Worker Impact (garment) 60.5
0 - 33 Low Impact		34 - 66 Medium Impact		+66 High Impact

Figure 2EIM Report of sustainable wash process

Report Process: Asmara #355D (Sustainable) Sample

STEPS

<p>1 - Whiskers</p> <p>Manual operation</p> <p>Time: 3 min</p>	<p>2 - Hand Sand</p> <p>Manual operation</p> <p>Time: 2 min</p>	<p>3 - Desize</p> <p>Washing machine (Horizontal)</p> <p>Time: 10 min Temperature: 50°C LR 1:8 Gradient 4 °C/min Recycled water? No</p> <p>Chemicals Stones (Pumice) 1 kg / kg Anti-back staining 2 g / L Base Deterpal EP-Q New 1 g / L</p>	<p>4 - Enzyme</p> <p>Washing machine (Horizontal)</p> <p>Time: 50 min Temperature: 45°C LR 1:6 Gradient 4 °C/min Recycled water? No</p> <p>Chemicals Enzyme (Neutral cellulase) 2 % owg Stones (Pumice) 1 kg / kg Anti-back staining 2 g / L Base Deterpal EP-Q New 1 g / L</p>
<p>5 - Stone Out</p> <p>Manual operation (minutes)</p> <p>Time: 5 min</p>	<p>6 - Bleach</p> <p>Washing machine (Horizontal)</p> <p>Time: 20 min Temperature: 50°C LR 1:10 Gradient 4 °C/min Recycled water? No</p> <p>Chemicals Calcium Hypochlorite 10 g / L</p>	<p>7 - Bleach</p> <p>Washing machine (Horizontal)</p> <p>Time: 15 min Temperature: 50°C LR 1:10 Gradient 4 °C/min Recycled water? No</p> <p>Chemicals Calcium Hypochlorite 8 g / L</p>	<p>8 - Neutral</p> <p>Washing machine (Horizontal)</p> <p>Time: 5 min Temperature: 40°C LR 1:6 Gradient 4 °C/min Recycled water? No</p> <p>Chemicals Sodium Metabisulfite 1 g / L</p>
<p>9 - Cleaning</p> <p>Washing machine (Horizontal)</p> <p>Time: 10 min Temperature: 50°C LR 1:8 Gradient 4 °C/min Recycled water? No</p> <p>Chemicals Hydrogen Peroxide 3 g / L Anti-back staining 2 g / L Base Deterpal EP-Q New 1 g / L</p>	<p>10-Tint</p> <p>Washing machine (Horizontal)</p> <p>Time: 5 min Temperature: 45°C LR 1:8 Gradient 4 °C/min Recycled water? No</p> <p>Chemicals Direct dyes 0 % owg</p>	<p>11- Rinse</p> <p>Washing machine (Horizontal)</p> <p>Time: 2 min Temperature: 25°C LR 1:8 Gradient 4 °C/min Recycled water? No</p>	<p>12- Extract</p> <p>Hydro Extractor</p> <p>Time: 3 min</p>

13- Tumbler and Dryer	14- Destroy Laser Mark	15- Destroy Opening	16- P.P Spray
Tumbler dryer	Laser Cleanlogia Flexi HS	Manual operation	Manual operation
Time: 30 min Temperature: 60°C	Time: 60 s	Time: 3 min	Time: 2 min
			Chemicals Potassium Permanganate 10 g / L

17- Neutral	18- Rinse	19- Softener	20- Extract
Washing machine (Horizontal)	Washing machine (Horizontal)	Washing machine (Horizontal)	Hydro Extractor
Time: 5 min Temperature: 45°C LR 1:8 Gradient 4 °C/min Recycled water? No	Time: 2 min Temperature: 25°C LR 1:8 Gradient 4 °C/min Recycled water? No	Time: 5 min Temperature: 25°C LR 1:6 Gradient 4 °C/min Recycled water? No	Time: 4 min
Chemicals Sodium Metabisulfite 1 g / L		Chemicals Acid - Citric acid 0.5 g / L Beltasin OZK TR 1 g / L	

21-Tumbler and Dryer
Tumbler dryer
Time: 30 min Temperature: 60°C

ENVIRONMENTAL INFORMATION

GARMENT WEIGHT (KG): 0.4

Process name: Asmara Sustainable	Environmental Threshold: EIM FEBRUARY 2020	Process time: 3hr 41min		
47 Medium Impact	Calculated Impact			
	Water Impact (l/garment) 34.4	Energy Impact (kWh/garment) 1.52	Chemical Impact (garment) 51	Worker Impact (garment) 52
	Effective Impact			
	Water Impact (l/garment) 34.4	Energy Impact (kWh/garment) 1.52	Chemical Impact (garment) 51	Worker Impact (garment) 52
0 - 33 Low Impact		34 - 66 Medium Impact		+66 High Impact

3.3 Testing method

1. GSM Test: GSM was calculated for assessing the difference in fabric weight before and after the treatment according to ASTM D 3776.
2. Tear strength: Tearing strength of the samples evaluated by tear testing machine (Elmendorf Apparatus)according to ASTM D 1424-09 (R2013) standard.
3. Tensile Strength: Tensile strength of the samples evaluated by tensile testing machine according to Grab Method (ASTM D5034:2013) standard.
4. Conditioned: 65% Relative humidity (RH%) and 20°C for 24h before testing according to BS EN 20139 and ASTM D1776-09A (R2017)
5. EPI and PPI: Found by using count glass and needle by manual method.

3.3.1- recipe 1 and 2 differences Table

For First sample		
Process	time	water consumption
conventional	220min	1600L
sustainable	164min	500L
save	56min	1100L

Table 15 Recipe 1 and 2 differences

3.3.2- Recipe 3 and 4 differences

For Second sample		
Process	time	water consumption
conventional	201min	1360L
sustainable	94min	820L
save	7min	520L

Table 16 Recipe 3 and 4 differences

3.3.3- EIM report result analysis

Sustainable Info						
Process	Water impact Garment/L	time	Energy impact	Chemical consumption	Worker impact	EIM Score
Conventional	66.4	4hr 10min	1.61 kWh	57	60.5	63
Sustainable	34.4	3hr 41min	1.52kWh	51	52	47

Table 17 EIM report analysis

3.3.4-Impact on GSM

SL	GSM Before wash	GSM After wash	Weght loss %
1	370	359	2.97
2	408	390	4.41
3	365	350	4.1
4	368	355	3.53
5	389	373	4.11
6	409	395	3.42

Table 18 Impact on GSM

3.3.5 Impact on Tear Strength

Sample	Warp Tear Strength Before wash	Warp Tear Strength After wash	Warp Tear Strength loss %
1	13.6	11.4	16.17
2	8.6	7.1	17.44
3	14.2	12.3	13.38
4	14.6	12.3	15.75
5	9.8	7.5	23.46
6	9.7	7.9	18.55

Table 19 Impact on Tear Strength

Sample	Weft Tear Strength Before wash	Weft Tear Strength After wash	Weft Tear Strength loss %
1	17.1	13.6	20.46
2	8.8	5.7	35.22
3	16.5	13.4	19.02
4	18.1	14.2	21.54
5	12.4	9.2	25.8
6	8.6	5.3	38.37

3.3.6-Impact on Tensile Strength Table

Table 20 Impact on Tensile Strength

Sample	Warp Tensile Strength Before wash	Warp Tensile Strength After wash	Warp Tensile Strength loss %
1	203.5	154.3	24.7
2	166.8	125.3	24.9
3	156.7	113.3	27.69
4	210.4	155.2	26.23
5	168.9	126.2	25.28
6	150.7	113.2	24.29

Sample	Weft Tensile Strength		Weft Tensile Strength loss %
	Before wash	After wash	
1	122.6	105.2	14.19
2	82.5	63	23.63
3	114.2	93.5	18.12
4	119.9	107.4	10.42
5	94.3	81.4	13.79
6	72.8	56.6	22.25

3.3.7-Impact on EPI and PPI Table

Sample	EPI-Before wash	EPI-After wash	Difference	average
1	92	96	4	3.36=3
2	89	92	3	
3	91	94	3	
4	91	95	4	
5	92	94	2	
6	90	94	4	

Table 21 Impact on EPI and PPI

Sample	PPI-Before wash	PPI-After wash	Difference	average
1	53	56	3	2.16=2
2	51	53	2	
3	50	52	2	
4	53	54	1	
5	50	53	3	
6	52	54	2	

Chapter-4 Result and Discussion

4.1 GSM Changes and Weight Loss Percentage

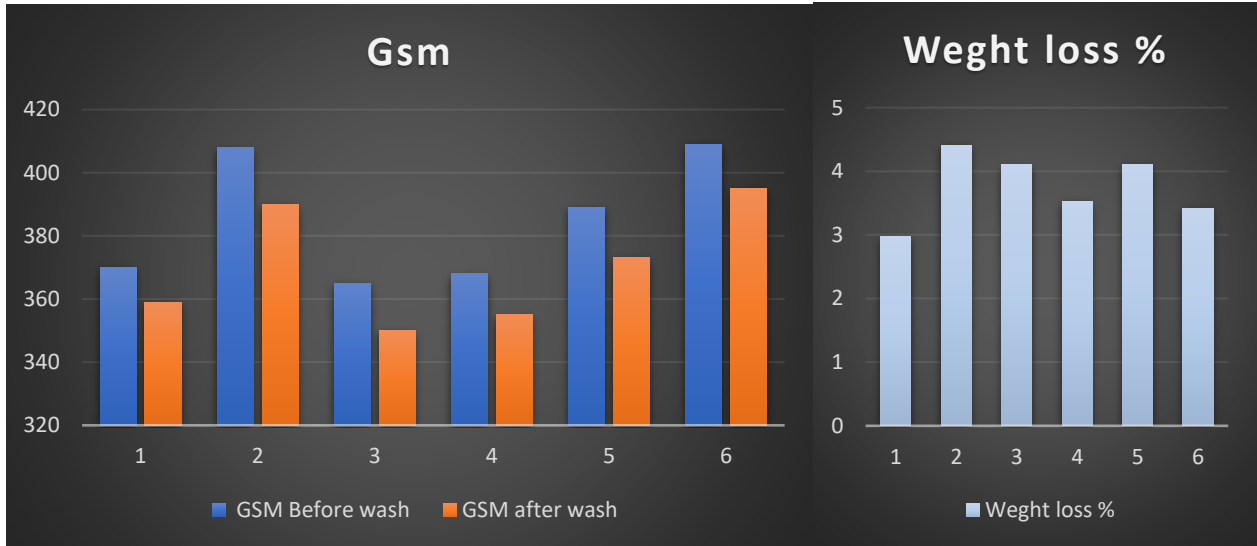


Figure 3 GSM changes and Weight loss percentage

Denim Before Wash GSM was 370 and after wash GSM was 359. So, we saw that the GSM was decreased

In the after-wash GSM was decreasing

4.2 Tear Strength Changes

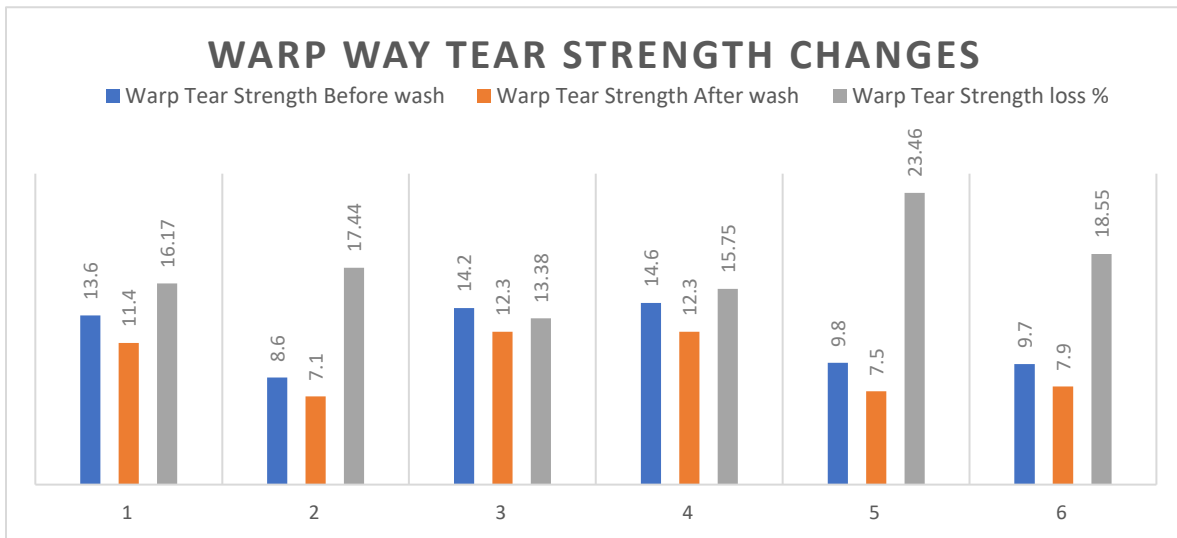
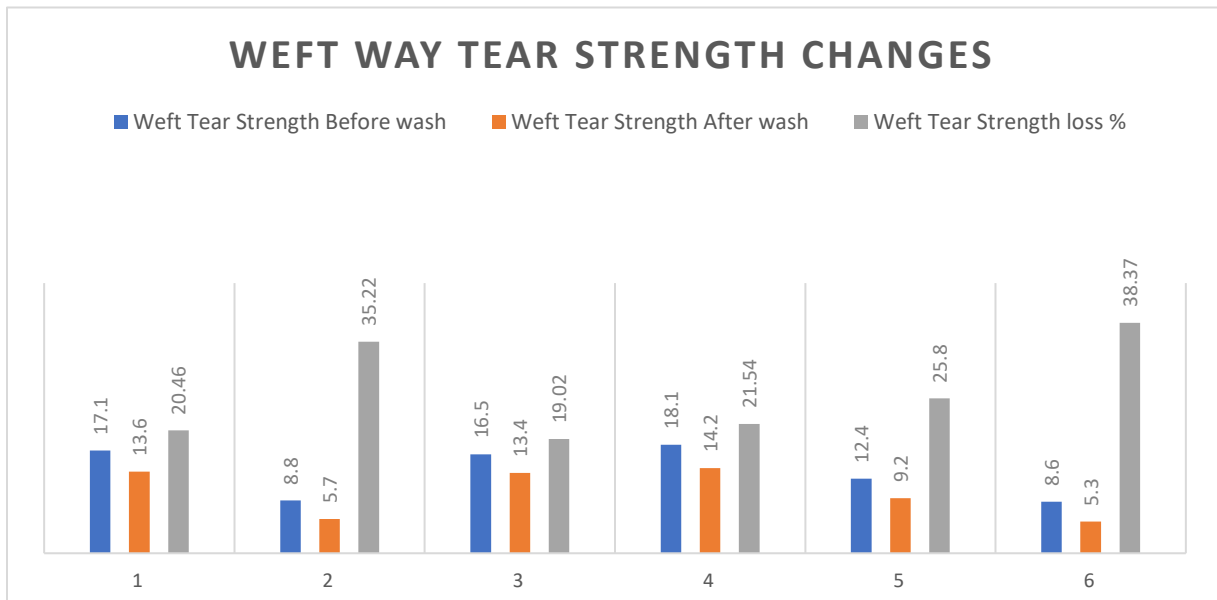


Figure 4 Tear Strength Changes

In the fig: We measured the warp tear strength for Denim before wash and after wash. We measured the Warp Tear Strength loss percentage.

As a Example we saw that, Denim Warp tear strength (before wash) was 13.6 and After Wash was 11.4

The Warp Tear strength loss percentage is 16.7%. In After wash tear strength is decreasing comparing with before wash in the same denim.



In the fig: We measured the Weft tear strength for Denim before wash and after wash. We measured the Weft Tear Strength loss percentage.

As a Example we saw that, Denim Weft tear strength (before wash) was 17.1 and After Wash was 13.6

The Weft Tear strength loss percentage is 20.46 %. In After wash tear strength is decreasing comparing with before wash in the same denim.

4.2.1 Tensile Strength Changes

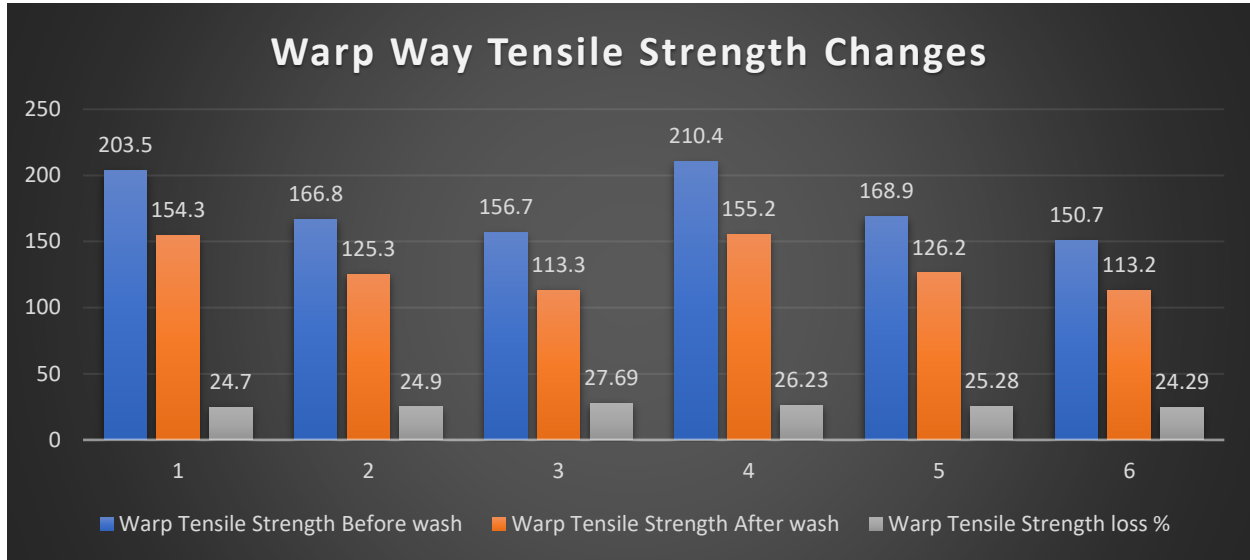


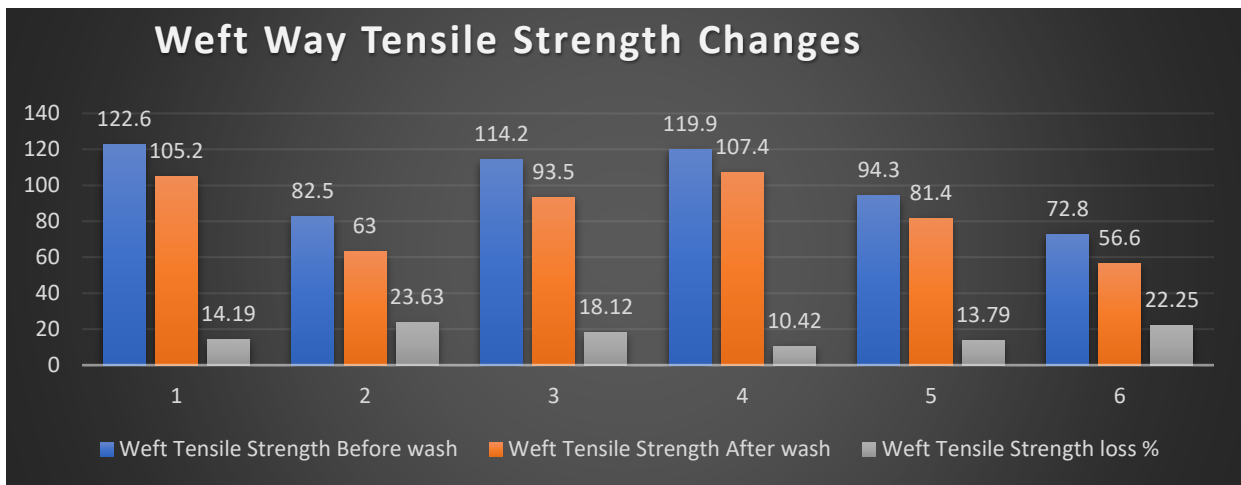
Figure 5 Tensile Strength Changes

In the fig: We measured the warp tensile strength for Denim before wash and after wash. We measured the Warp Tensile Strength loss percentage.

As a Example we saw that, Denim Warp tensile strength (before wash) was 203.5 and After Wash was 154.3

The Warp Tensile strength loss percentage is 24.7%.

In After wash warp tensile strength was decreasing compared with before wash in the same denim.



In the fig: We measured the weft tensile strength for Denim before wash and after wash . We measured the Weft Tensile Strength loss percentage.

As an Example we saw that, Denim Weft tensile strength (before wash) was 122.6 and After Wash was 105.2.

The Weft Tensile strength loss percentage is 14.19 %.

In After wash weft tensile strength was decreasing compared with before wash in the same denim

4.3 EPI, PPI CHANGES

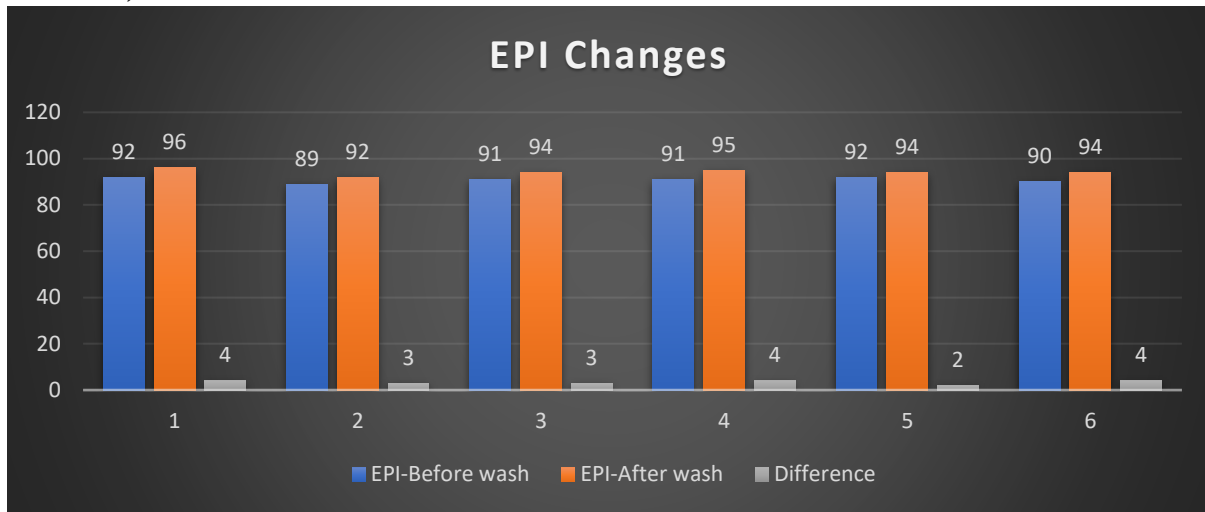
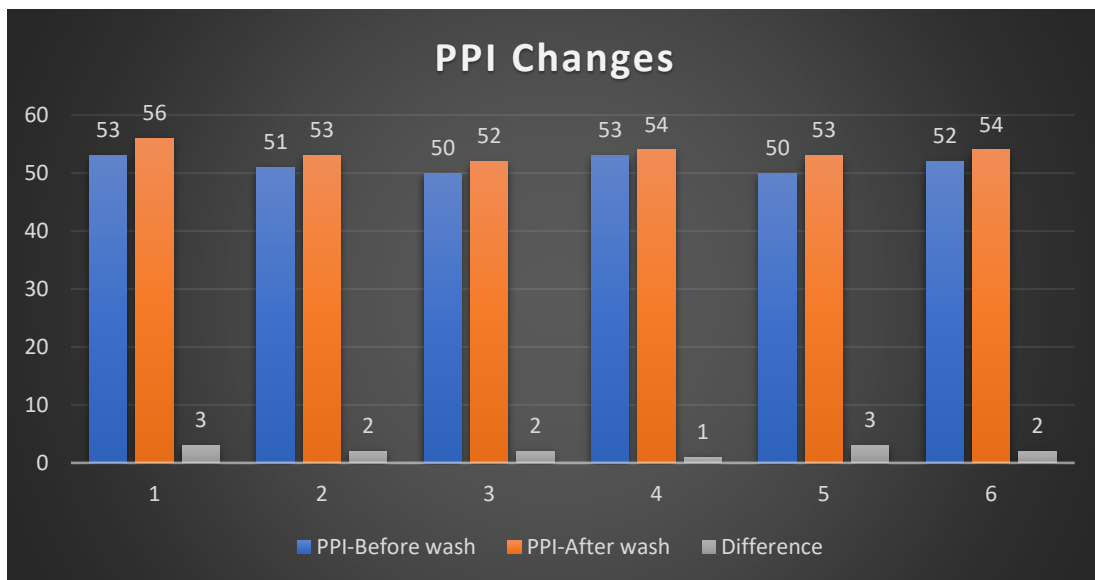


Figure 6 EPI PPI Changes

In the chart we found that EPI(Ends per inch) for denim After wash and Before wash. We saw that after testing the After-wash EPI was increased, compared to before wash. As a example we saw that In the chart Denim before wash EPI was 92 but after wash EPI was 96.

So we found that after washing EPI will be increasing.



In the chart we found that, PPI (Picks per inch) for denim After wash and Before wash. We saw that after testing the After-wash PPI was increasing, compared to before wash. As a example we saw that Denim before wash PPI is 53 but after wash PPI is 56.

So we found that after washing EPI is increasing.

4.3.1 Conventional and Sustainable wash and EIM report

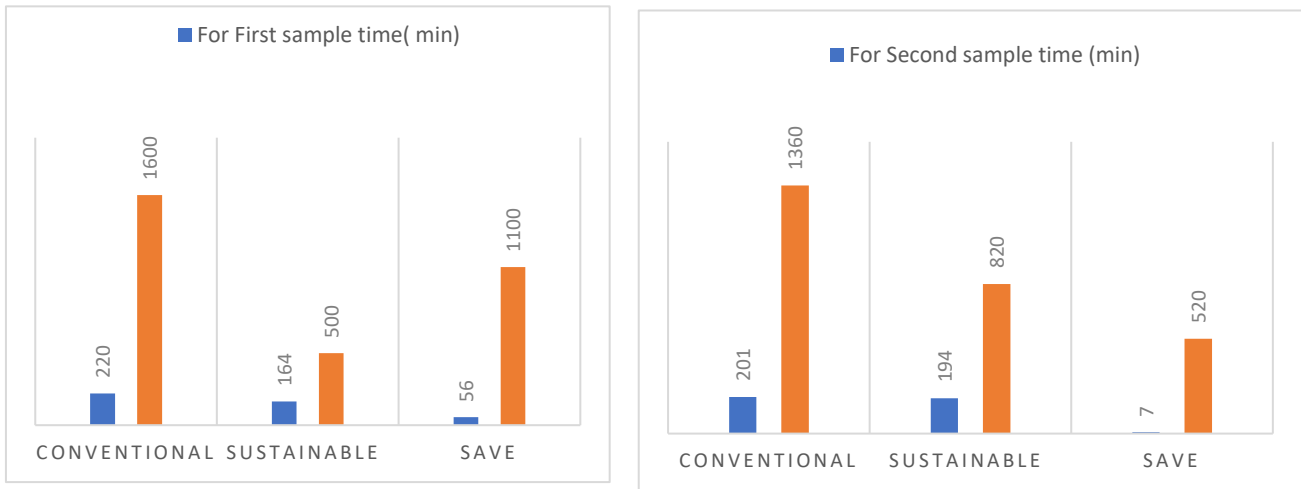
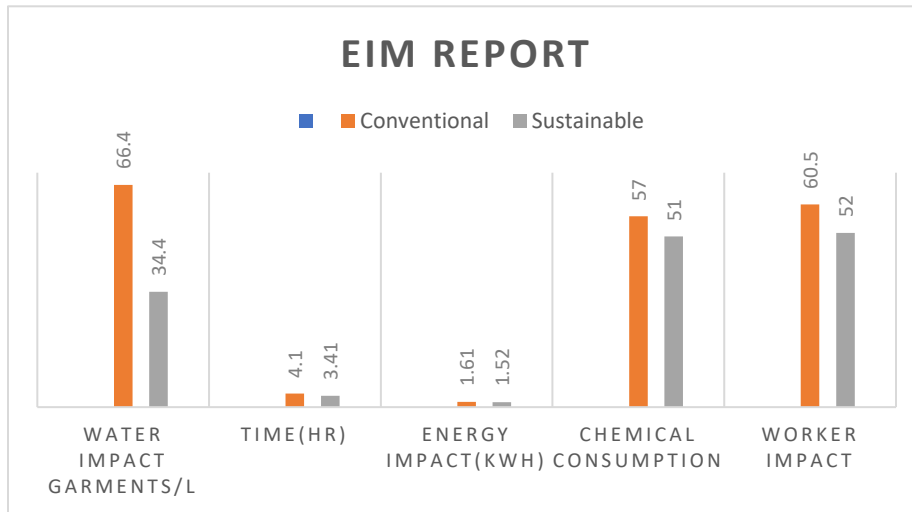


Figure 7 Conventional and sustainable wash and EIM report Analysis graph



We analyzed the EMI report on conventional and sustainable wash. We found that Energy, water impact, Chemical consumption, are decreased or low in sustainable wash. Sustainable wash is environment friendly and energy saver.

We had done the entire test in before wash and after wash. Each graph shows the results of before and after wash denim leg panels.

In this project we try to compare the denim conventional wash and sustainable wash. After completing the report, we found that sustainable wash is far better compared to conventional wash. It saves chemical, water, power energy. Its impact on environment is fruitful. Consumer safety and workers safety also included in sustainable wash. We try to find out fabric effect on before wash and after wash. In the end we finally agree that sustainable wash is more suitable than conventional wash but in our country the machinery and skill workers shortage. So it will be harder for us to maintain sustainable wash.

Chapter-5

Conclusion

To complete this research work Denim pant is used. The composition of denim pant (cotton 75%, polyester 18%, Lycra 7%). Due to the presence of lycra in the fabric, shrinkage was increased both in warp way and weft way but weft way shrinkage was higher than warp way direction. In EPI, PPI both are increased after denim wash. In this project we try to point out denim sector and denim upcoming process (sustainable wash process) and conventional process. we try to compare these processes and testing some process like (Tear, Tensile strength, GSM.EPI, PPI). Our world is polluted is day by day. Denim polluted our environment badly but we are earning a lot of economy by denim sector. So that is the reason we need to denim wash in a sustainable way, which is benefit for us and environment also. So, this is the reason we try to describe something about sustainable denim wash and its process, and its impact on our upcoming days. At the end we must tell that Denim future in our countries is very bright, we must follow the sustainable way to developed much more.

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