# Computational analysis of plain weft knitted fabrics for the study of air permeability and thermal conductivity

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**Abstract:** In this work, the combined influence of both the properties including Air Permeability and Thermal Conductivity of knitted structures is analyzed. For this purpose, different plain weft knitted structures were developed by using multiple fibers (i.e. polyester, polypropylene, and acrylic) and of different yarn specifications (i.e. staple, mono & multifilament). The developed computational models were validated with the actual values of the fabrics extracted from image analysis and then used for the parametric analysis to evaluate the effect of structural parameters including stitch density and thickness over the air permeability and thermal conductivity of the fabrics.

***Keywords:*** *Computational modelling,Weft knitting, Polyester, Polypropylene, Acrylic, Air permeability, Thermal Conductivity.*

Knitted structures are formed by rows of intermeshing loops. The basic unit of knitted structure is the loop. The loop is made from a needle loop, sinker loop and loop column [1]. The loop length is considered to be the main parameter of the knitted structure. The different parameters like loop width, loop height, loop length (l), yarn thickness (d), and fabric thickness have been most frequently examined to predict the dimensional features of knitted materials [2].

Many researchers have worked over the development of geometrical models of single jersey weft knitted structures [3-11] and over the evaluation of the air permeability [12-14] and thermal conductivity [15-18] of fabrics by using the experimental approach. The aim was to investigate these properties by using the computational analysis approach in order to determine the variation in the obtained results due to difference of type of fibers, yarn types and knitting parameters as shown in Table 1. In other words, it can be said that the presented study would greatly help the manufacturers in research and development through which the pre-production optimization and quantitative assessment of different type of fabrics for determination of their functional characteristics would be possible.

Figure 1 and Figure 2 represent the methodology used to evaluate the effective thermal conductivity and air permeability of plain weft knitted fabric.

**Table 1** Specifications of plain weft knitted fabrics

| Fabric Code | Fiber Type | Yarn Count (tex) | *Stitch Density* $(cm^2)$ | *Stitch Length* (mm) | *Thickness* (mm) |
|---|---|---|---|---|---|
| F1 | Polyester (mono) | 27 | 17.92 | 8.22 | 0.49 |
| F2 | Polyester (multi) | 19 | 66.56 | 5.54 | 0.76 |
| F3 | Polypropylene (multi) | 112 | 34 | 6.33 | 1.2 |
| F4 | Acrylic (Staple) | 50 | 51.24 | 3.93 | 1.4 |

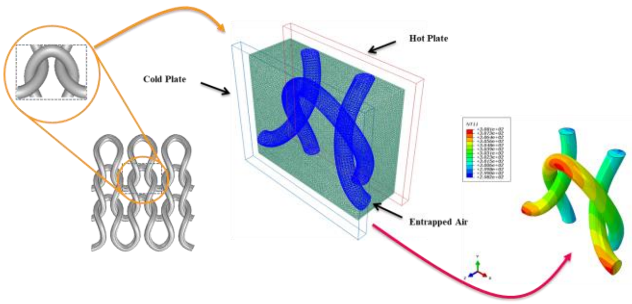


**Figure 1** Methodology to evaluate Thermal Conductivity

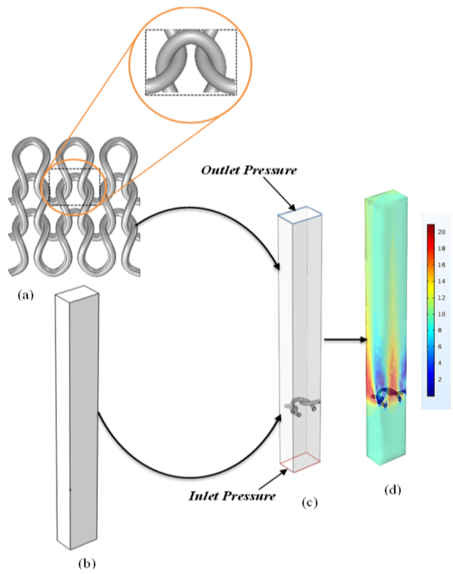


**Figure 2** Methodology to evaluate Air Permeability: (a) 3D model of plain weft knitted fabric, (b) air domain, (c) air domain with unit cell model & (d) Simulated velocity profile