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made of medical grade Silastic silicone tubes (VWR, PA, USA) with internal diameter of 4.78 mm and external diameter of 7.95 mm. The length of the sample tubes was 371 mm. The tubes were spliced to complete the loop with similar silicone tube, approximately 25 mm long, 7.95 mm internal diameter and 12.70 mm external diameter. The wall shear rate for this model has been previously defined by Gardner.[12] Here it has been converted to wall shear stress (WSS) by using the Newtonian relation $\tau = \mu\gamma$, where τ is the fluid shear stress, γ is the shear rate of the fluid, and μ is blood dynamic viscosity. Hence it becomes,

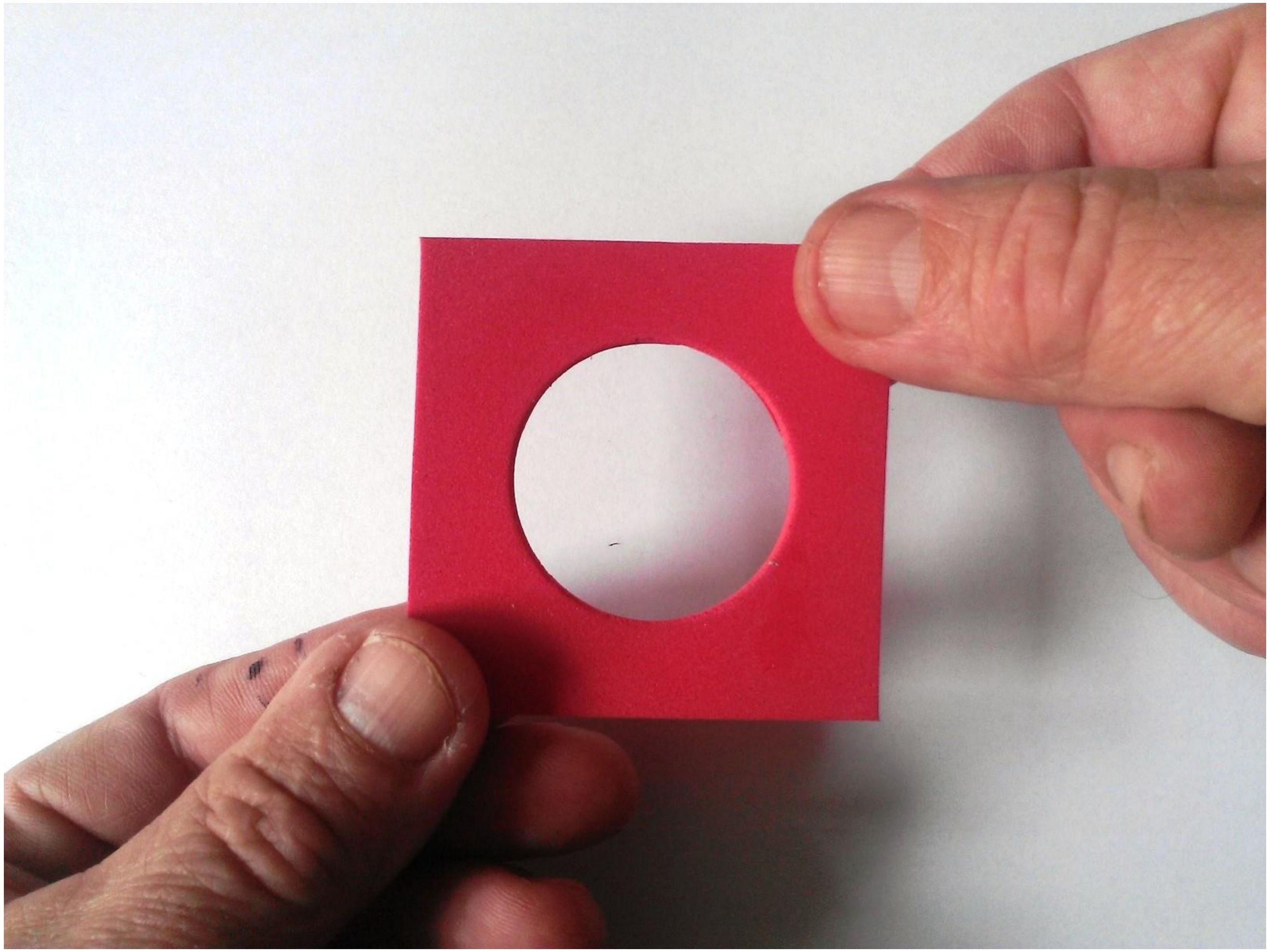
$$\tau_w = \frac{2\pi R_0 \omega \mu}{15R} \quad (1)$$

where R_0 is the loop curvature radius, R is the tube internal radius, and ω is angular velocity in RPM.

this text is a little bit confusing and not really correct.

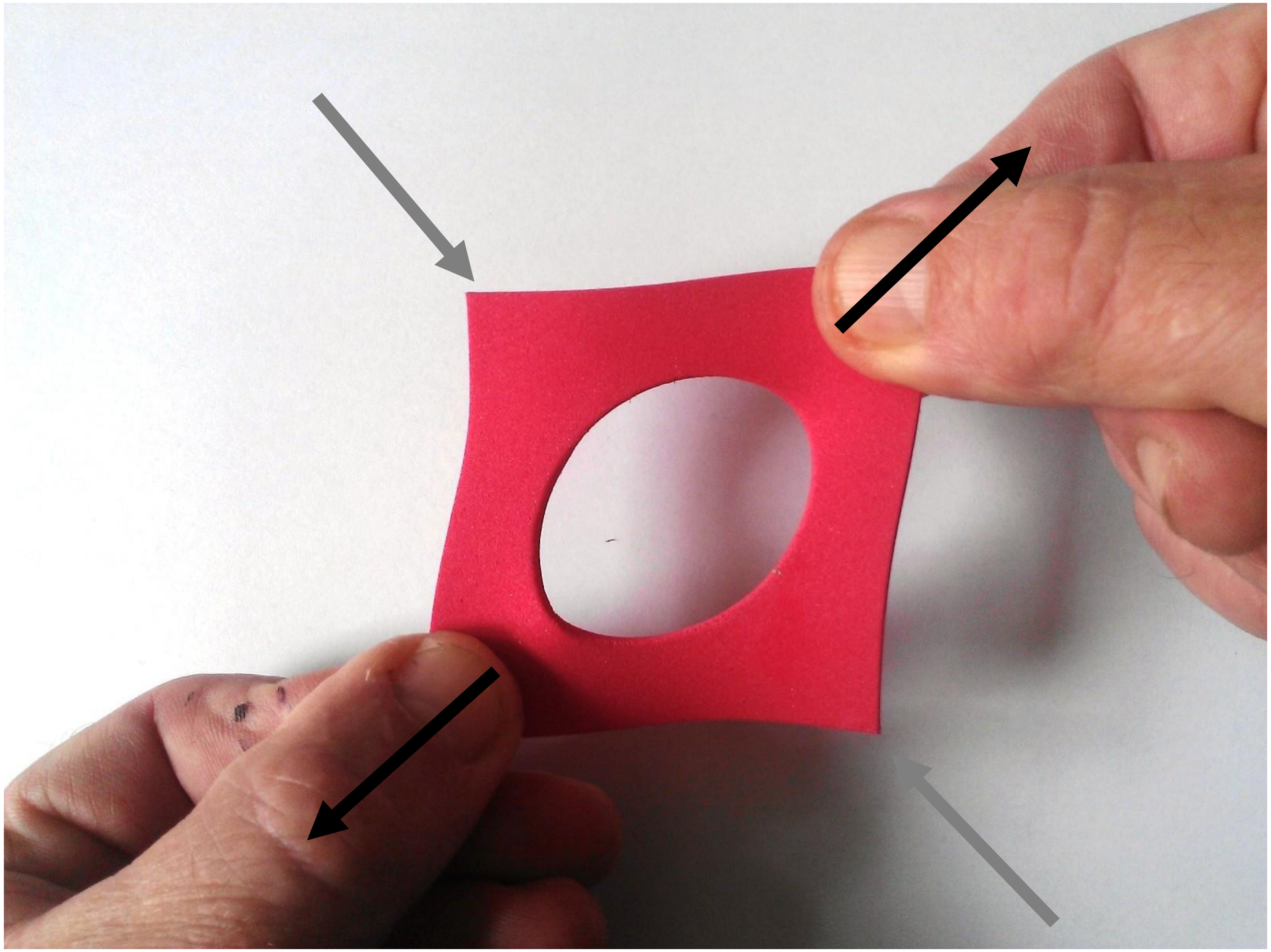
I'd like to get show you a more demonstrative model…

blood sheer stress



This is a piece of soft cellular rubber with a circular hole.

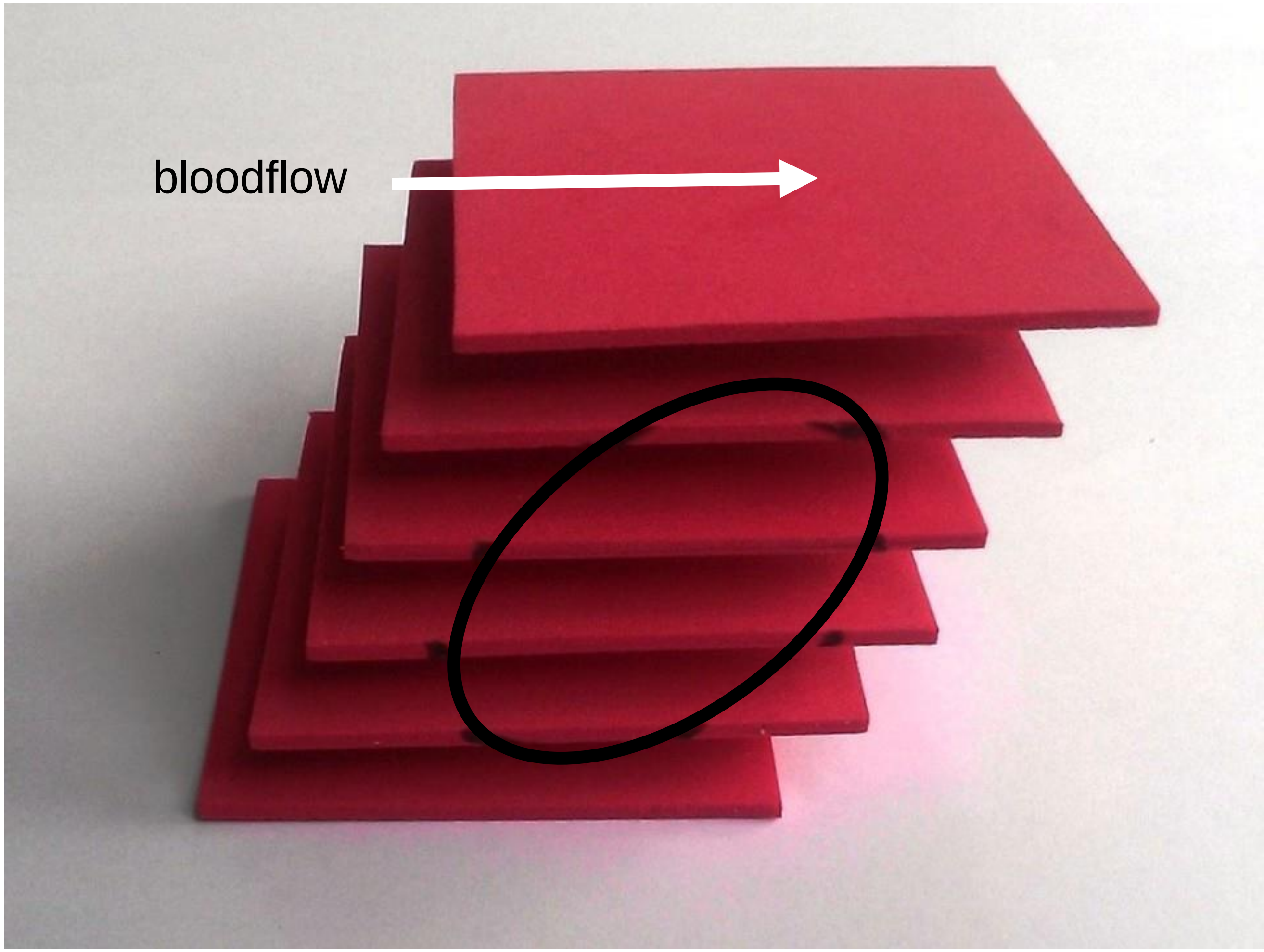
blood sheer stress



This is a piece of soft cellular rubber
with a circular hole.
Pulling the opposite corners,
you see the effect of the force (or of the tension)
on the deformation of the hole.

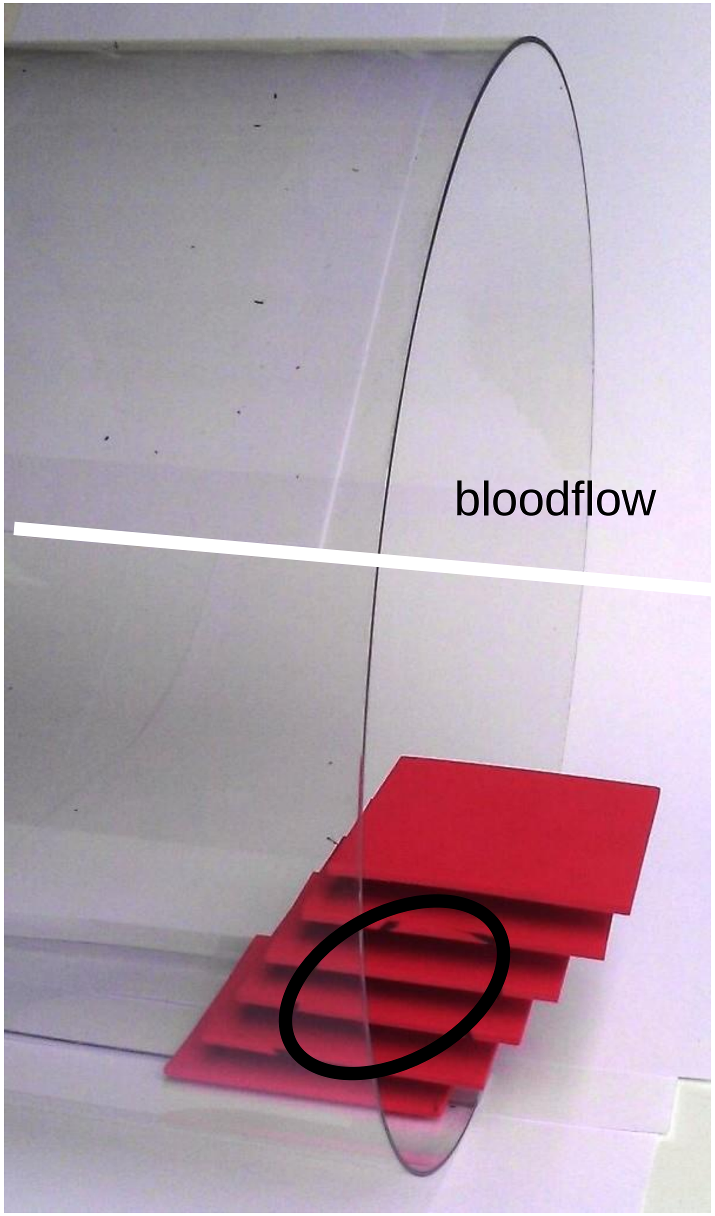
To create the same effect,
you can push the other corners as well..

blood sheer stress



The same effect on a laminar blood flow

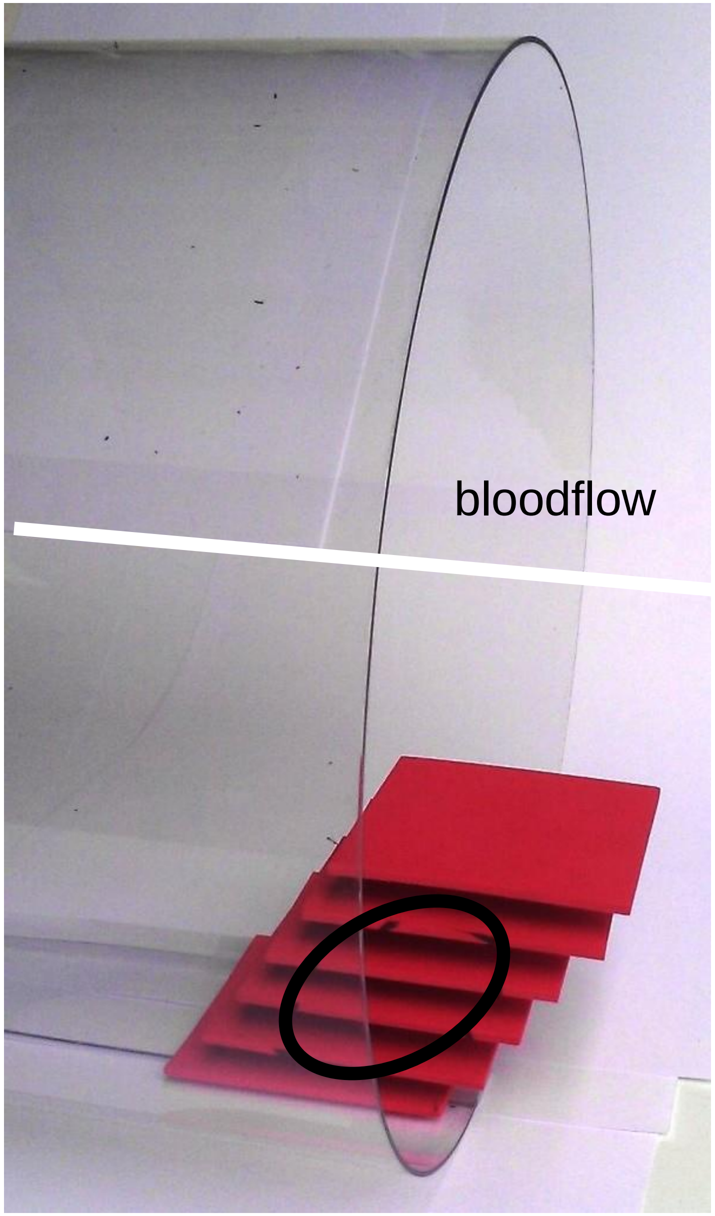
blood sheer stress



blood sheer stress

The same effect on a lamiar blood flow inside the tube.
The blood sticks to the wall of the tube.
The velocity is zero.

More distance to the wall means more velocity of the blood.

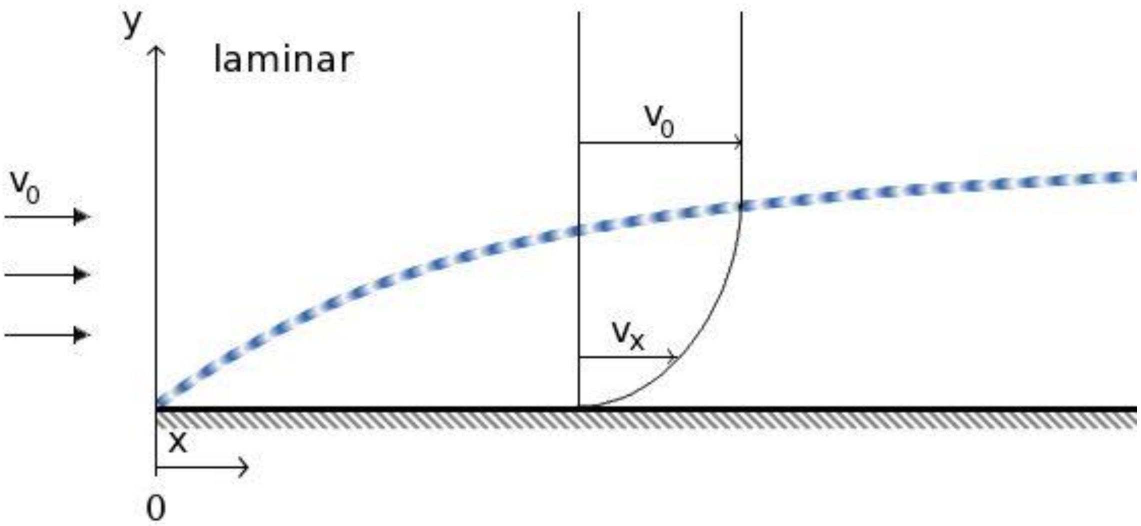


blood sheer stress

The same effect on a lamiar blood flow inside the tube.
The blood sticks to the wall of the tube.
The velocity is zero.
More distance to the wall means more velocity of the blood.

But this increase is not linear.

In the center of the tube the velocity has its maximum.



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where R_0 is the loop curvature radius, R is the tube internal radius, and ω is angular velocity in RPM.

back to the formula:

Ro (loop radius in the center of the tube)
and
R (inner radius of the tube)

are parameters of the geometry of the tube.

unit is [m] (Meter)

blood sheer stress

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$$\tau_w = \frac{2\pi R_0 \omega \mu}{15R} \quad (1)$$

where R_0 is the loop curvature radius, R is the tube internal radius, and ω is angular velocity in RPM.

2π Ro is the periphery of the tube

ω is the angular velocity.

unit is [$\frac{rad}{s}$]

(rad is only a number, like rounds…)

and what the hell is rad (radiant)??

the animation works only in presentation mode !!

1 round (2π rad)
per minute (60 s)
is the same as:

$\frac{2\pi\ rad}{60\ s}$

blood sheer stress

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$$\tau_w = \frac{2\pi R_0 \omega \mu}{15R} \qquad (1)$$

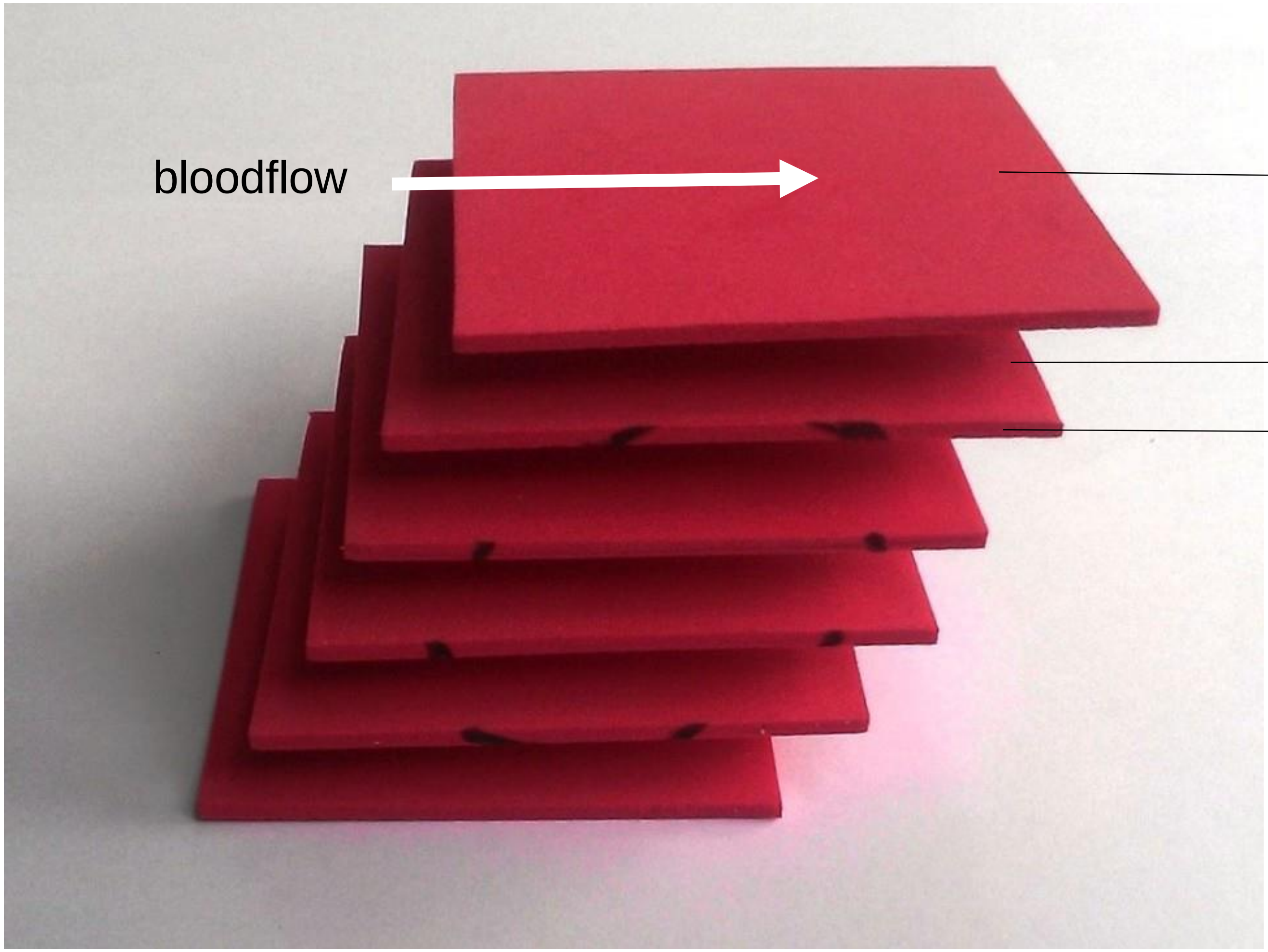
where R_0 is the loop curvature radius, R is the tube internal radius, and ω is angular velocity in RPM.

μ is the dynamic viscosity of blood.

It is a material specific constant,
which describes
the thickness of a fluid
and its ability to flow…

again the model:

blood sheer stress



blood sheer stress

Dynamic Viscosity

you take a surface

with a certain dimension,

a fluid (the blood)

and a reference surface.

It takes a certain force to slide the parallel surfaces depending on the fluid. If the fluid is thick, the force is higher than if you take a very liquid fluid.

Unit of force is [**N**] Newton
unit of the surface is squaremeter [$\mathbf{m^2}$]

N per m^2 is used also for pressure:
another name for the same is **Pa** (Pascal)
or 1/1000 is **mPa** (milli Pascal)
(you‘ve already heard this in the weatherreport)

And the whole effect of dynamic viscosity
(it moves: time is relevant)
is measured with the unit [**Pa·s**]

Viscopedia ❱ Viscosity Tables ❱ Whole Blood

Whole Blood

Description

Blood viscosity is a measurement of the thickness and stickiness of an individual's blood. It is a direct measure of the ability of blood to flow through the blood vessels.

Blood measurement determines how much friction the blood causes against the vessels, how hard the heart has to work to pump the blood through the body, and how much oxygen is delivered to organs and tissues.

Blood viscosity is correlated with all known risk factors for cardiovascular disease. Elevated blood viscosity is a strong independent predictor of cardiovascular events.

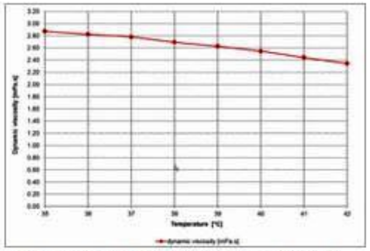
Page Content

Description
Data
Reference

the dynamic viscosity of blood depends on its temperature.

Measurement data

Temp. [°C]	Dyn. Viscosity [mPa.s]	Kin. Viscosity [mm²/s]
42	2.35	2.24
41	2.44	2.33
40	2.55	2.43
39	2.63	2.51
38	2.69	2.57
37	2.78	2.65
36	2.82	2.70
35	2.87	2.74



Whole Blood - dynamic viscosity over temperature

blood sheer stress

$$\tau_W = \frac{2\pi R_0 \omega \mu}{15R}$$

now all components together:

2π Ro (in **m**, 1 mm = 0,001 m) the periphery of the loop

the circular velocity
ω (in rounds / second , 1 Rpm = **1 / 60s**)

the dynamic viscosity
μ (in **Pa · s** , 1/1000 Pa = 1 mPa)

and **R** (in **m**, 1 mm = 0,001 m)

to check the whole equation, you fill in only the units without dimension number:

$$\tau_w = \frac{m \cdot \frac{1}{s} \cdot Pa \cdot s}{m}$$

$$= \frac{\cancel{m} \cdot \frac{1}{\cancel{s}} \cdot Pa \cdot \cancel{s}}{\cancel{m}}$$

$$= Pa = \frac{N}{m^2}$$

blood sheer stress

done