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The Missing Piece: Suspension Losses

Posted on August 8, 2016

How does it work that wide tires are as fast as narrow ones? It is really simple:

Comfort = Speed

When your bike vibrates, energy is dissipated as friction. That energy must come from somewhere – it no longer is available to propel the bike forward, so your bike slows down. That is why your bike rolls faster on smooth pavement than on rough chipseal.

At *Bicycle Quarterly*, we started testing tires on real roads, with a real rider, in 2006. We found that higher tire pressures don't make your bike faster. Back then, that was pretty revolutionary. Previous tests on smooth drums had shown that the harder you pumped up your tires, the faster you went. But smooth steel drums aren't a good model for what happens on real roads, and the results were misleading.

Over the last couple of years, our findings have become generally accepted. Most tech writers now talk about vibrations that slow down your bike. The missing piece is: How do vibrations slow you down? The most common explanation is that your bike goes up and down as it vibrates. All that climbing adds up and costs a lot of energy.

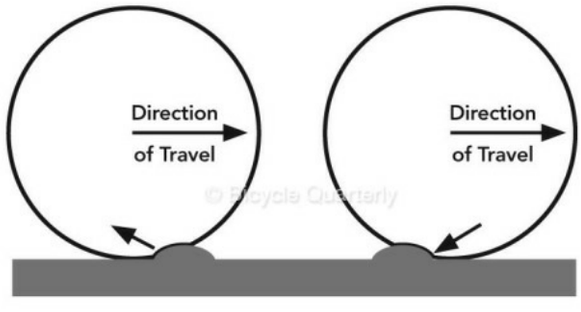
It's true that vibrations slow you down, but it's a bit more complicated. Energy cannot disappear. The only way to "lose" energy is to convert it to heat through friction. When you climb a mountain pass, you put in energy as you gain elevation. As you descend on the other side, you get some of it back – you can coast downhill without pedaling – but most of it is converted to heat by your wind resistance. During the descent, your bike accelerates until you reach "terminal velocity", where the energy input from the elevation loss equals the energy consumed by wind resistance.

That explains where the energy goes when you cross a mountain pass. It cannot explain what happens when your bike vibrates on flat roads.

We tested various equipment on rumble strips to get a maximum value for the energy that is lost to vibrations. We found that riding on this “very rough” road can take up to **290 Watt more** power than riding on smooth pavement at the same speed. So it’s true, vibrations can absorb a huge amount of energy. It was almost impossible to keep the bike moving at our testing speed on the “very rough” road. (Of course, in real life, you don’t ride on rumble strips, but the point was to see how much energy could be lost just by changing the surface roughness, and keeping everything else the same.)

Since we were going at the same speed as on the smooth pavement, the our wind resistance was the same, and yet we had to push the pedals with 290 Watts more. So where did all the energy go?

A little bit went into heating the tire as it flexes, but pneumatic tires don’t absorb much energy even when they bounce. Think of a basketball. When you drop it, it bounces back almost as high as before. Very little energy is lost, even though it deflects as it hits the ground. As the basketball hits the ground, it compresses and becomes an air spring. Then it stops, before it starts accelerating upward again. The “spring” in the ball returns most of the energy, and the ball bounces almost as high as it did with the last bounce.



Tires work the same way. When a tire hits a bump (left), it deforms (arrow). Energy is stored – the tire becomes a compressed spring. On the other side of the bump (right), the energy is released, pushing the tire off the bump. The net loss of energy is small.

If the energy isn’t lost in the tire, then where does it go?

The answer is simple: As the rider's body vibrates, the tissues (muscles, tendons, skin, etc.) rub against each other. This can convert an enormous amount of energy into heat. How much? In a study of vibrating tank seats, the U.S. Army found that up to 2000 Watt were absorbed by a human body before the vibrations became too painful to endure. The discomfort was directly proportional to the energy loss.

2000 Watt! That is more than the power output of a pro racer. Clearly, a lot of energy can be lost due to these vibrations. The technical term for this is **"suspension loss"**. It also occurs in shock absorbers of cars – rally cars' shock absorbers absorb so much energy that they get hot – so hot that they need dedicated cooling.

We also tested different types of equipment on the new, super-smooth pavement next to the rumble strips. We were surprised that even on very smooth pavement, reducing vibrations through supple tires – and even, to a lesser degree, a suspension fork – resulted in significant performance gains.

What this means for cyclists is simple: If your bike's vibrations are uncomfortable, it's because energy is converted into heat, inside your body. This energy is lost from the forward motion of the bike. As far as vibrations are concerned, being uncomfortable slows you down. Or seen the other way around, the more comfortable your bike is, the less power goes to suspension losses, and the more power is available to drive it forward:

Comfort = Speed

It really is that simple. And it's revolutionized how we think about bikes: Wide, supple tires are faster because they vibrate less. Fork blades that absorb road shocks – even suspension forks – are faster, not just on rough roads, but even on relatively smooth roads, because they reduce vibrations. On real roads and at the speeds most of us ride (<25 mph), the best "gravel" and "Allroad" bikes actually are faster than their racing bike cousins.

This means that the biggest improvement in your bike's performance comes from a set of wide, supple tires. "Supple" means that the casing is thin and easy to flex. This has two benefits:

1. Supple tires are easy to flex, so they transmit fewer vibrations (lower suspension losses). That is Reason 1 why they are faster.
2. Supple tires are easy to flex, so it takes less energy as they deform them as they rotate (lower hysteretic losses in the tire casing itself). Reason 2 why they are faster.

Wide tires also transmit fewer vibrations, which makes them faster than narrower ones.

Our testing shows that supple casings are more important than width. A supple 26 mm tire is much faster (and more comfortable) than a stiff 38 mm "touring" tire. Of course, ideally, you'll get it all – a wide **and** supple tire.

This research led us to develop our Compass tires. While quite a few makers offered supple racing tires in widths up to 25 mm, there weren't (and still aren't) many great high-performance tires in wider widths. So we worked with one of the best and most experienced makers of bicycle tires – Panaracer in Japan – to create the fastest, most supple tires possible.

For our Extralight series, we use a casing that usually is reserved for high-end, hand-made racing tubulars. On top goes a layer of extra-grippy, yet long-wearing, rubber with our trademark tread pattern that interlocks with the road surface for extra grip. The result are our Compass tires – available in widths from 26 mm to 54 mm.

Before releasing these tires in 2014, we tested them extensively on some of the roughest gravel roads to ensure they were durable enough for real-world riding. Since then, they've proven themselves in gravel races, but also on paved courses like *Paris-Brest-Paris*. They even took second place in the Washington State Road Racing Championships. The riders who use them are our best advertisers, recommending them to everybody who is willing to listen. We rarely advertise – instead, we focus on new research that will improve our products even further.

Further reading:

- *Bicycle Quarterly*'s research on tire performance and suspension losses.
- More information about Compass tires.

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62 Responses to The Missing Piece: Suspension Losses

vintagebicyclerepairman *says:*
August 8, 2016 at 5:22 am

Hi, your tests are very interesting and I mounted wide supple tires since I read some of the articles (Panaracer Pasela 35mm at the moment). It really improved handling and comfort.
But what would be interesting, did you also test the rolling resistance at speeds of 30 or 40kph? Is there a point from where wide tires have more resistance than narrow ones (on asphalt)? Further on when does wind resistance become a problem (today bladed spokes are standard on fast biycles for better aerodynamics).
If these questions where already answered I would be thankful for a link.
Best Regards
Gerald

Jan Heine, Editor, Bicycle Quarterly *says:*
August 8, 2016 at 6:37 am

We tested at 29.5 km/h (18.7 mph), which isn't exactly slow. The faster you go, the more important wind resistance becomes. The big problem is that this introduces more noise in your "real-road" measurements. If your rider, while circling the track, changes their position ever so slightly, it'll make a larger difference in the power output required to ride at that speed. So you won't be able to discern small differences in rolling resistance any longer.

However, we did test the wind resistance of wider tires in the wind tunnel, and the effect was much smaller than most people think. When you think about it, a few millimeters in width don't increase the frontal area by that much, compared to the rider's body. So it appears that wide tires will be as fast as narrow ones at higher speeds – on smooth roads. On rough roads, they'll be faster, because the suspension losses are more important, and wide tires reduce them more. And if you draft while riding at high speeds, then your wind resistance is greatly reduced, and rolling resistance becomes even more important.

Consider that the pro racers in the Tour now all are on 25 mm tires, because they roll faster, even at Tour speeds, than 20s or 23s. And these are super-thin (and light) riders, riding on very smooth roads. And they ride tubulars, which reduce the suspension losses further. For the rest of us, riding clinchers on average roads, to reduce the suspension losses to the same degree, we'll have to ride 32 mm tires or wider.

Lastly, your Paselas offer great value for money, but as far as suppleness and speed is concerned, I'd call them mid-range. Try some truly supple and fast tires some day!

vintagebicyclerepairman *says:*
August 8, 2016 at 7:28 am

Thank you Jan. The weight of the rider (and the bicycle too) is a good point.
I use the Pasela on my everyday bicycle so price/performance is important. I've got a Grand Randonner too which I'm going to test soon.

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zigak *says:*
August 8, 2016 at 5:32 am

I would like to see an experiment where the bike with rider would be loaded with a.) steel ingots and b.)meat of the same weight. Then use a power meter to calculate the differences in power losses.

Jan Heine, Editor, Bicycle Quarterly *says:*
August 8, 2016 at 6:42 am

That would be interesting. We already know that the steel, if mounted securely on the bike, wouldn't slow you down much on a flat course.

When you drop a ball bearing on the floor of your workshop, it bounces almost like a basketball. The suspension losses are minimal. On the other hand, when you drop a slab of meat, it doesn't bounce at all. The ball bearing doesn't have much internal friction; the slab of meat does.

WillK *says:*
August 8, 2016 at 11:27 am

Wouldn't the power losses be the same with a steel ingot and a slab of meat? When riding with a steel ingot, the vibrations that would have been absorbed by the slab of meat would instead be absorbed by the OTHER slab of meat (the rider). My guess is the power losses would be equal, but the steel ingot scenario would result in a less comfortable ride.

Some anecdotal evidence: This summer I toured gravel and paved roads from Banff to San Diego on my Cross Check with 40mm Marathon Supreme tires and bikepacking bags. When I would unload the bike and ride around town the bike did not feel a whole lot faster, but it DID feel much less comfortable and stable over speedbumps and potholes.

Next time I'll dumpster-dive a rump roast, strap it to my seat post, and report back.

Jan Heine, Editor, Bicycle Quarterly *says:*
August 8, 2016 at 11:35 am

That is an interesting question! I suspect that the more things you vibrate, the more energy is absorbed. Otherwise, a tandem would be twice as comfortable as a single bike, since the vibrations of the two wheels are absorbed by twice as many riders. So each rider should only get half the vibrations! In real life, it doesn't work that way 😉

Eric Steig *says:*
August 8, 2016 at 7:55 am

How does suspension play into this? Isn't this an argument for road bikes with lightweight suspension forks (like the Cannondale Slate)?

Jan Heine, Editor, Bicycle Quarterly *says:*
August 8, 2016 at 7:59 am

Yes, we found that suspension can reduce the energy consumed by bike and rider, even on smooth roads. Against that, you have to consider the weight and complexity. Our own bikes use "passive" suspension: thin fork blades that can flex over bumps, but that don't require maintenance and don't add weight.

Cyclosomatic *says:*
August 8, 2016 at 8:58 am

I am a big fan of 'passive suspension' too, an elegant solution to the vibraton problem. Another option I've tested a bit is the suspension stem approach. I don't think the technology is all the way cooked still, but I see a lot of potential. The nice thing with a suspension stem is that it adds less weight than a fork, and allows you to maintain a more aerodynamic fork shape. A well-refined stem with perhaps 20mm travel would be quite effective, especially when coupled with a suspension seatpost like the Specialized example. http://teknecycling.com/matter-stafast-suspension-stem/

David *says:*
August 8, 2016 at 10:00 am

I love my Compass Tires but it would be fair to give some due credit to Grand Bois who introduced a wide range of wide, supple tires many years ago. They also use the chevron tread on their 650 x 32B tire.

Jan Heine, Editor, Bicycle Quarterly *says:*
August 8, 2016 at 10:04 am

The first Grand Bois tires weren't very supple. They used the Pasela casing. Through our research, we were able to work with Grand Bois to make their tires more supple and faster. Now we've taken the same approach one step further with our Compass tires, which pick up where the Grand Bois left off.

DaveS *says:*
August 8, 2016 at 10:15 am

The article talks about the irregularities in the road surface that causes vibration. It should be noted that the rider also induces vibrations while pedaling. This became apparent to me recently when I was getting a bike fit. One of the techniques that the technician used to determine a proper fit was to see how much the stationary fit bike moved/vibrated while I was pedaling with each adjustment. A good bicycle fit with proper length cranks will reduce reduce the wasted movement which increases efficiency. Although it can be reduced, there is still wasted movement (and we all do this) and this energy has to go somewhere. I suspect this is a factor of why the BQ real world tests show that supple tires are faster even on smooth pavement.

BTW, I did get surprising results from the bicycle fitting. I have always used the size cranks that came stock on a bicycle. This has always been in the range of 170-175mm. The fitting clearly showed that I pedal more efficiently (with more power output) with 165mm cranks. As a result, I would suggest a good fitting instead of relying on formulas when determining optimal crank length.

Bryan *says:*
August 8, 2016 at 12:31 pm

I'll be running Barlow Pass extralite at the D2R2 (Deerfield Dirt Road Ride) 100K on August 20th. Rough and steep by my standards. Are you familiar with it? I'll let you know how they do. I've always run Schwalbe Marathon Supremes so this is a big change for me. I hate flats and would rather carry the extra weight but I must say that the Barlow Pass are mighty comfortable. Stay tuned.

Jan Heine, Editor, Bicycle Quarterly *says:*
August 8, 2016 at 12:38 pm

Depending on your weight and riding style, 38 mm tires are a bit narrow for a really rough course. Make sure you inflate them enough to avoid pinch flats! To optimize traction, comfort and speed, you might be better off with even wider tires, but of course, you also would need a bike that can wear them.

Good luck on D2R2!

Cyclosomatic *says:*
August 8, 2016 at 12:52 pm

I've ridden D2R2 on 28s (crappy) and seen it done on a fat bike. In my mind 38s are ideal, because they provide lots of contact patch for the steeper climbs, but none of the tread that would do nothing on the loose surfaces. I think it would be fun on 42s too, but as Jan says, that's easier said than done. There's one descent that is fast (80kph if you want) and rough. Take that mellow and you're golden!

Jan Heine, Editor, Bicycle Quarterly *says:*
August 8, 2016 at 12:57 pm

Some day, I want to take the Firefly with its 54 mm tires on that event. The difference in speed and control during fast, but rough, gravel sections is amazing, even when compared to the 42s I usually ride.

Cyclosomatic *says:*
August 8, 2016 at 1:07 pm

You should, Jan. I'll get down there to ride it with you; it's been a while since I did it. THe Firefly looks near perfect. I adapted my Niner 29er hardtail for D2R2 and similar riding, with drop bars and 50mm Schwalbe Furious Fred tires, which are very supple and fast. I've ridden the bike a lot, but it's mostly been a disappointment, because it's too high off the ground. Even with the 'big' tires it's not stable at speed, because it's so high. The Firefly wouldn't have this problem. I saw a Seven in that format, but with 42s, at D2R2 maybe 4 years ago, and thought: ding ding, nailed it! Maybe I should borrow some 650b wheels and try them on my Niner.... It'd look horrible, but would ride better.

Bryan *says:*
August 8, 2016 at 4:42 pm

Thanks to you (and Jan) ! I'm a tourist, not a racer so it's all about the visuals for me. I weigh 170lbs 🙂 Last year I used my "Armageddon bike", Tout Terrain Silkroad with 26×2 Schwalbe Marathon Extremes. It worked fine but heavy on the up hills as you can imagine. This year I'm riding a Seven Evergreen with a SRAM 1x. For me, it's a real featherweight and with the Bardlow Pass, very nice on the road. BTW, am thinking about the Rat Trap for the Silkroad but not sure if my fenders will accommodate the 2.3. I think they might since they are a bit oversized for the 2″.

Willem *says:*
August 8, 2016 at 1:13 pm

This year I fitted the Rat Trap Pass to my 26 inch loaded tourer, replacing the Compass 26×1.75. I had been a bit concerned about the rather wide size, but on my Exal SP19 touring rims they measured 51 mm, leaving enough clearance under the universal Long Shen fork crown. The 60 mm Berthoud fenders fitted fine as well.
The ride improvement on camping tours with some 12-15 kg of luggage was immediately obvious. Comfort was much improved and much more than the improvement from the 26×1.75 Pasela to the 26×1.75 Compass. It was also much better than the Big Apple in similar size. These tyres are obviously also faster. The speed improvement was biggest on gravel roads, where the bike seemed to ride almost as fast as on tarmac. But even on smooth tarmac the bike was clearly a bit faster. The only drawback was on wet trails. The lack of any real tread could make for suddenly tricky riding, and required subtle and very attentive steering. Mud would be even worse, of course, to the point of impossible. No punctures yet.

Jan Heine, Editor, Bicycle Quarterly *says:*
August 8, 2016 at 1:24 pm

I am glad that you enjoy the Rat Trap Pass tires so much. You are right, on mud, you need widely spaced knobs if you want to optimize traction. The only issue is that knobbies like that roll terribly in almost every other condition. It's a trade-off: If you ride mostly in mud (like cyclocross), get knobbies. Otherwise, you may be better off "underbiking" 2% of the time than pushing knobbies 98% of the time when they slow you down.

47hasbegun *says:*
August 8, 2016 at 1:59 pm

I did the same when I rode my Surly Troll to the un-meeting in Carson. They were definitely comfortable, but it was pretty difficult to find a medium between "too squidgy" and "too bouncy" with four panniers. I was only riding pavement with the four panniers. They were pretty amazing without the panniers while I was riding with the group, though.

I'm replacing that Troll frame (71mm trail) with something that has 36mm of trail (and tubing that is less stout!) soon, following the philosophy pioneered with Jan's enduro all-road bike. Can't wait to see how it does with the Rat Trap Pass tires.

Bob C *says:*
August 8, 2016 at 1:59 pm

I've recommended Compass tires to a dozen friends in the last year and to a person, everyone who has made the jump finds the benefits spectacular.

But that's not the reason for my response. Instead, it's this: I wonder if the muscle/tissue vibration you discuss also is damped by compression garments. (But then where will the energy go?)

Every study I've read has called into serious doubt the giddy performance benefits claimed by makers of compression garments (better blood flow, etc.). But there appears to be some support in studies for the notion that compression garments improve recovery as well as the speed of recovery.

What you're saying about the suspension losses impact on soft tissue makes a lot of sense (and that's a lot of wattage on those rumble strips!) and if the compression garments further dampen these losses at the muscular level, it seems the micro-injuries to the muscles and soft tissue might be reduced.

I feel that since I moved to Compass Babyshoe Pass tires my comfort level (and speed) has increased and rides that would leave me knackered aren't so much so. If compression garments (I've never worn them) further reduce the impact of the vibration in soft tissue, perhaps that would ward off a bit more fatigue.

The question then would be, are these the most marginal of marginal gains and would it justify the (I imagine) relative discomfort of compression garments?

Jan Heine, Editor, Bicycle Quarterly *says:*
August 8, 2016 at 2:10 pm

That is an interesting thought. I know that when you sit on a vibrating car seat, you tense your muscles, perhaps to reduce the discomfort from the suspension losses. I guess the big question is this: Does compression from the outside do enough to limit the internal friction of the body's tissues?

Ray Varella *says:*
August 8, 2016 at 3:35 pm

In regards to suspension losses in body tissues; would an extremely lean person experience lower suspension losses compared to someone of more average body fat composition and even lower still compared to someone with higher ratios of body fat?

Jan Heine, Editor, Bicycle Quarterly *says:*
August 8, 2016 at 3:51 pm

That is a good question – I don't think we know the answer. Perhaps the U.S. Army study would tell us, but it's been a long time since I looked at it.

Mark Finch *says:*
August 8, 2016 at 5:24 pm

Several weeks ago I replaced the Schwalbe Marathons on my Atlantis with a pair of Rat Trap Pass tires. My goal was to be able to better ride the rural gravel roads near my home, and they work wonderfully for that. But what I've really come to appreciate is the comfy ride on my daily commute, which is on a variety of pavements including a brick street. The tires are much quicker than the Schwalbes, and I certainly appreciate that. But I think you're underselling the Michelins-on-a-Mercedes ride quality.

Gunther *says:*
August 9, 2016 at 3:42 am

1. Riders are flesh, not meat. The more vibrations you have, the more your muscles work to stabilize the body. I'd guess this is where a good part of the energy goes, not just internal friction of the body tissues.

2. There is one little drawback using rumble strips for the experiment: they are periodic patterns, real roads have random roughness. In physics periodicity can cause serious effects, e.g. if you hit the eigen-frequency of a system. So the literal 290 Watt should be taken with a grain of salt.

3. Recently I swapped standard Grand Bois Hêtres for Compass Babyshoe Pass Extralights. A real surprise how smooth they feel.

Jan Heine, Editor, Bicycle Quarterly *says:*
August 9, 2016 at 7:38 am

You make very good points. It would be nice to get a more random surface, but it also has to be repeatable. If you use real cobbles, every run will be different, because you'll hit bigger or smaller cobblestones depending on the line you take. The rumble strips always are the same.

I am glad you enjoy the Compass tires as much as we do!

Flying Lizard *says:*
August 9, 2016 at 1:09 pm

This may have been covered elsewhere, and if so I'd be happy with a link to the answer/discussion… but what are your insights into the pros/cons/tradeoffs involved in riding a given clincher tire set up "tubelessly" vs. running the same tire with a tube, testing at various pressure levels in each scenario? Jan, is this a subject of any of your past, present, or future research?

It would be interesting to understand the puts and takes related to such factors as the weight of the tube, friction between the tube and the tire, the weight and sloshing movement of the sealing fluid, the option to ride tubeless at lower pressures for a given level of pinch-flat resistance, etc.

Thoughts?

Thanks!

Jan Heine, Editor, Bicycle Quarterly *says:*
August 9, 2016 at 6:50 pm

We are currently testing tubeless tires as part of our tire testing program, which also tests really wide tires: At what point are wider tires not faster, but actually slower. There must be a point where this happens, but we don't know yet where…

We'll publish the results in *Bicycle Quarterly* as soon as the testing is complete.

SmoothestRollingBike *says:*
August 10, 2016 at 10:23 am

Could you please test Rat Trap Pass tires with Michelin C4 Latex 26×1.50/2.20 tubes?

Jan Heine, Editor, Bicycle Quarterly *says:*
August 10, 2016 at 10:55 am

In past testing on real roads, both by us and others, Michelin latex tubes made the tires roll slightly **slower**. We don't know why, but in the very least, we can say that latex tubes are not faster than butyl tubes.

Jonathan Blum *says:*
August 9, 2016 at 5:39 pm

One question that this brings up is where does all that heat go? Should we have a fever after riding on a rough road? If you assume for thermal purposes that a human body is reasonably approximated by a bucket with 70 kg of water, then it would take about 80 watts to raise the temperature of the bucket by 1 degree Celsius in one hour (without any cooling). Higher amounts of power would raise the temperature proportionately. Since most of us don't ride on rumble strips, one might imagine that the heat burden might be on the order of what's imposed by 80 watts, or perhaps double that on some roads.

This is within the ability of the body to dissipate heat. Actually, it's not far from the basal metabolic rate. So the amount of heat generated by even a pretty rough road is not so much that one would expect the rider to heat up substantially from that effect.

On a related note, for years we have been told (not on these pages) that flexible frames lose power (presumably based on the idea that the frame does not act like an efficient spring). The "lost" energy has to go somewhere, so wouldn't it be converted to heat in the frame? I wonder if this alleged loss could be measured in a lab environment by measuring temperature change in the frame.

Jon Blum

Jan Heine, Editor, Bicycle Quarterly *says:*
August 9, 2016 at 6:54 pm

As you point out, the human body would need to absorb a lot of energy before it got hot. That said, after riding on rumble strips all morning, I could feel it all over my body!

Yes, energy lost to frame flex would heat up the frame, but you have a lot of surface (and at least with metal, a good conductor) for effective cooling. So don't expect your bottom bracket to get hot. (Car tires do get hot, though, which is why you should check the pressure when they are cool.) Interestingly, for the same amount of flex, carbon fiber absorbs more energy than metal.

Oreste Drapaca *says:*
August 9, 2016 at 7:46 pm

Where does all the heat go ? Perhaps it goes to heat the surrounding atmosphere…

Jon Blum *says:*
August 10, 2016 at 9:40 am

Heat can be lost from the body by conduction, convection, evaporation (sweating), radiation, and exhalation of hot air (the latter probably a major mechanism in my case). Heat from the bike itself will mostly be transferred to the air. As Jan pointed out, the bottom bracket won't heat up noticeably from this effect; metal is a great conductor and will quickly conduct heat away and into the moving air. That's why I mentioned "lab environment" as the only place one could perhaps measure this effect. Regarding entropy, I think that is most relevant to the chemical changes that occur during metabolism (e.g., oxidation of fuels), but I have not thought much about Gibbs free energy in 40 years, so perhaps someone whose physics is a bit fresher can comment. If you are interested in how energy expenditure by the body is measured, search the internet for "human calorimeter."

Oreste Drapaca *says:*
August 9, 2016 at 7:47 pm

I was wondering if any discussion on energy ought to mention entropy.

John Clay *says:*
August 10, 2016 at 4:32 am

Another wonderfully informative article and it makes perfect sense. It also causes me a problem; after finally clearing the decks and being ready to build myself a frame around the BSP, I have to figure out if the RTP would be preferable!

Jan Heine, Editor, Bicycle Quarterly *says:*
August 10, 2016 at 6:13 am

I think you'll be perfectly happy with the Compass Babyshoe Pass 650B x 42 mm tires, unless you ride mostly on gravel. In that case, I'd recommend the Rat Trap Pass 26″ x 2.3″.

Patrick Broyer *says:*
August 10, 2016 at 6:50 am

I have Bon Jon pass extra-supple 700- 35c tires made up tubeless and love the ride feel and low rolling resistance. I'm using Stans Race Sealant and have a problem with the rate of air loss being high. I have to pump them up 3 times on a 400 kilometer ride. The loss-rate has diminished with time and after shaking the wheel to distribute the sealant on the sidewalls. It's not rim, stem, or tape: Hutchinson Intensives hold air just fine but are a harsh ride. Is there anything I can do short of switching to the standard, less supple version or using a tube? I'm using plain air. Loss was higher with CO_2, haven't tried N_2.

Jan Heine, Editor, Bicycle Quarterly *says:*
August 10, 2016 at 7:27 am

The supple casing of Compass tires isn't airtight by itself. To do this would result in harsh-riding, slow tires like the Hutchinsons you tried.

The secret appears to use enough sealant and to distribute it well. The last set of Compass Extralights I set up tubeless sealed well immediately, and just required one topping up with air, then held their pressure for over a week. Maybe others who run these tires tubeless with so much success can chime in.

Cyclosomatic *says:*
August 10, 2016 at 11:02 am

I run the Bon Jons tubeless with Stans, and have had great luck with sealing. However, this might have something to do with them coming on and off a few times, which could help to dry sealant in pores. Make sure you shake the sealant well before applying. Perhaps add a little through the valves before your next ride and see? Mine are so well sealed I don't even have to add air after days between rides. I do, to maintain the precise pressure I want, but I don't have to. I've hear Orange Seal is effective, but it seems rather expensive.....

James *says:*
August 10, 2016 at 7:49 am

Patrick,
In regards to your tubless extralight tires and air loss, I have had better success using Orangeseal vs Stans. Stans seams to dry into large clumps within the tire (Stanimals) whereas Orangeseal coat and dry evenly on the inside of the tire. Something to remember, with light, porous tires, one must add sealant more often than with thick, rugged MTB tires. If I can't hear sealant sloshing within the tire (grabbing wheel off the bike with both hands 3 & 9 and giving it a 'wiggle') there's not enough to do it's job in the event of a puncture.

Paul Brookshire *says:*
August 10, 2016 at 9:43 am

Here's a new one for you. My wife just completed a 10k and Marathon on a unicycle at the Unicon 18 event in San Sebastian. She uses a 29″ wheel with no gear. Avg speed for her is just over 9mph, but stronger riders with higher cadences can achieve 11-13 mph or so pretty easily. I am always trying to get her to run lower tire pressures, but she is reluctant. Since I do not ride, I can not speak to the level of vibrations and speed loss. Be curious to see if some sort of shock coupler in the frame or seat post would add some speed. We are in Seattle, Jan, if you want to explore the edges of uni-design. 🙂

Jan Heine, Editor, Bicycle Quarterly *says:*
August 10, 2016 at 10:11 am

We did find that a suspension fork was faster than a very stiff fork taken from a cheap hybrid bike… but tire pressure is more important, and tire casing construction is by far the most important. So if she can fit a faster, more supple tire… At least one unicyclist uses a Compass Barlow Pass 700C x 38 mm.

Peter Chesworth *says:*
August 10, 2016 at 4:21 pm

With wide and low pressure tyres, it would be interesting to ascertain the friction (if any) caused by the different radii between the centre of the tyre's contact patch, and the edge of the tyre's contact patch. It seems to me that as the tyre hits the ground, the outer edges would traverse the surface more quickly than the centre. Having said that, I appreciate the comfort and low rolling resistance of the BJPs. Despite the cost, a good value for money performance upgrade.

Bert *says:*
August 11, 2016 at 8:00 am

I've been following the tyres and suspension losses research for a while. But the 2000 watts figure has me wondering. As per my simple estimations, the human body (or say 70kg of water) would heat up very quickly at 2000 Watts, so I'm curious about those Army tests.

Jan Heine, Editor, Bicycle Quarterly *says:*
August 11, 2016 at 8:15 am

I am sure the body heats up at that point. Even at 290 Watt, which I experienced on the rumble strips, you feel a lot of movement in your body. Most of us have rubbed our hands together when it's cold to make them warmer. Some of the warmth comes from outside friction between the hands, but it's not like you get a burning sensation on your skin: Most of the warmth comes from the tissues inside your hands generating friction.

The reference for the Army study is in the *Bicycle Quarterly* article. It's also in the book *Bicycling Science* – Jim Papadopoulos was the one who dug it up.

Harald *says:*
August 11, 2016 at 10:28 am

While reading up on some of the old army studies, I came across this interesting article that looked at the power absorption at different vibration frequencies. I'm not sure how their experimental setup compares to the older studies, but their main finding is that "the amount of absorbed power increases with the frequency up to a peak in the range of 4–6 Hz during exposure at a constant acceleration level. Above this frequency range a gradual decrease in PAbs with increasing frequency occurred." It would be very interesting to do an analysis of the frequencies that occur on a bike under different conditions. Link to study: http://dx.doi.org/10.1016/S0021-9290(98)00011-6

Matt *says:*
August 11, 2016 at 1:18 pm

FYI, the Silca folks also have been testing rolling resistance related to tire characteristics and pressure, and I think their discussion compliments and expands upon the articles in BQ and discussed in Jan's blog. see: https://silca.cc/blogs/journal/part-4b-rolling-resistance-and-impedance

terrymorse *says:*
August 11, 2016 at 2:13 pm

You write: "As you descend on the other side, you get some [energy] back…but most of it is converted to heat by your wind resistance."

That's not entirely correct. While some friction heating occurs, that amount is minimal. Most of the losses are from kinetic energy transfer from the moving cyclist to the stationary air. As the cyclist rides, he leaves moving air in his wake. Moving that air requires energy. If you could measure the air speed in the cyclist's wake, you could calculate the energy transfer.

Jan Heine, Editor, Bicycle Quarterly *says:*
August 12, 2016 at 12:03 am

As you point out, there are many factors that cause aerodynamic drag… When I talk about "wind resistance", I mean all aerodynamic drag, not just the friction of air on the surfaces of air and rider. For the purposes of riding a bike, it doesn't really matter where the aerodynamic drag occurs, just that it slows you down!

Marco *says:*
August 12, 2016 at 4:06 pm

@terrymorse Jan is actually correct. All of the energy lost as aerodynamic drag, even the portion due to kinetic energy transfer, ends up being converted into heating of the air. Infact, after a while the moving air will become still again, but it will have a slightly higher temperature.

terrymorse *says:*
August 13, 2016 at 6:13 pm

Well, if you want to be technically correct, all energy is eventually converted to heat. But that fact is little use when looking at the actual problem of the energy losses of a solid body moving through a viscous fluid. Heat Transfer and Fluid Mechanics are separate Thermal Sciences subtopics for a reason (at least they were when I was studying them).

Jan Heine, Editor, Bicycle Quarterly *says:*
August 15, 2016 at 12:59 pm

Terry, this post isn't looking at the energy losses of a solid body looking through a viscous fluid. We are talking about suspension losses, and for the purposes of that discussion, wind resistance can and should be treated all as one to keep the focus on the real issues. If we discuss what makes up wind resistance in a future post, we'll be more specific.

Conrad *says:*
August 13, 2016 at 1:52 pm

The Compass tires have changed the way I think about bikes. I have ridden full carbon bikes and custom titanium bikes with lame tires and I feel that my own steel frame/fork bikes with good tires perform better in every way. Said in another way: putting mediocre tires on your Specialized S works while complaining that the Compass tires are not very durable is being penny-wise and pound foolish to an extreme degree. A high performance tire is inherently fragile. If you can afford that bike, you probably have a refreshable tire budget too. A recent review I read of the Compass tires complains about durabilty and that they won't hold sealant for a tubeless setup. Which is the other thing that mystifies me: what is with the tubeless infatuation? I see way more people on the side of the road with a burped tire than a punctured tube. It seems to me that the pressure required to avoid a burp is about the same as the pressure necessary to avoid pinch flats with a tube. Goat heads are the only reason I can think of to go tubeless.

Jan Heine, Editor, Bicycle Quarterly *says:*
August 14, 2016 at 12:25 am

> *A high performance tire is inherently fragile.*

This used to be true with narrow tires. The 21.5 mm tubulars I raced in the 90s completely exploded when they punctured. But with wider tires, I don't have that problem any longer. Even in cyclocross, I have ridden a set of "fragile" FMB tubulars for three seasons, and they still are fine. My Compass Babyshoe Pass tires (650B x 42 mm) easily last 5000 miles…

> *A review I read of the Compass tires complains about durabilty and that they won't hold sealant for a tubeless setup*

I think you are referring to the review in Cyclocross Magazine. They had their 700C x 35 mm rear tire develop some leakage after riding it extensively over very rough surfaces. It's the first time we've heard about this issue. We've asked them to get the tire back to check whether it's a defective tire or just riding too rough a surface on too narrow a tire at too low a pressure. You are right, with an inner tube, that tire still would be fine, but that model is intended for tubeless, and shouldn't start to weep air…

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thebvo *says:*
August 14, 2016 at 12:08 am

"We rarely advertise – instead, we focus on new research that will improve our products even further."

Really? This here isn't advertising? In the past 5 years how many articles and in-depth reviews on tires and parts that you don't sell have been featured here or in BQ vs ones that you do? Does not this article, along with much of the research driven journalism at BQ, directly link to the sale products on the same website or at least remind us why Compass products are best? Regardless of which came first – the chicken or the egg (research or the product).

I ride Compass tires as much as possible because there is no denying how amazing they truly are! Although, I'm avoiding buying new ones even though I am way past the need for new tires! (good tires, like money, don't grow on trees 🙂

But if this blog and BQ (Again, I love both) are going to try to keep distance and a lack of a conflict of interests between itself and Compass Cycles' products, then there needs to be some ink devoted to other products that aren't being profited by the same people reviewing it.

You've written before about this issue of a conflict of interests and there is always a disclaimer at the end of the articles, but I think its fair to say that things have changed here – for the better because of the better tires (again, thanks for this awesome wide and fast rubber on the road!). But they've also changed because of the closing gap between journalism and advertising. Regardless of which came first – the chicken or the egg (research or the product).

BQ has changed my cycling world for the better – much better! I hope it continues to.

Jan Heine, Editor, Bicycle Quarterly *says:*
August 15, 2016 at 1:21 pm

I understand your concern about conflicts of interest. I share that concern. Just to clarify: This blog isn't impartial. It's my blog that gives you an inside view of what is going on at Compass and *Bicycle Quarterly*. The magazine itself tries to be impartial. Articles are published if they are of interest to our readers, not because they are in Compass' interest. The two can overlap, of course, as you note: You call our tires "amazing" – Wouldn't you want *Bicycle Quarterly* talk about a product that is so amazing? By the way, we also talk a lot about other amazing products, which we don't sell, like leather saddles or frames made from thinwall tubing.

In the end, this blog and *Bicycle Quarterly* aren't the only sources of information. Google "Compass tires", and you'll find many glowing testimonials that echo your positive impressions of our tires. And even here, readers like you are able to weigh in.

I am always surprised how many companies want their communications to be cheerleaders for their products. At Compass, we think that an open discussion is serves our interests much better, because it gives us far more credibility. If our products don't stack up well against the competition, we don't defend them, but we improve them instead!

I feel that is the only way to create excellent products. And since we ride what we sell, we have an interest in improving our products that goes beyond simple business considerations. I wrote about that here.

Conrad *says:*
August 14, 2016 at 9:38 am

In my experience, a cotton casing or compass extra Leger tire will typically fail at the sidewall in some way before the tread is worn all the way down. Whereas the standard casing compass I can usually wear the tread down to the casing. I still consider the extra Leger tires an excellent and even unsurpassed value given their performance.

Jan Heine, Editor, Bicycle Quarterly *says:*
August 20, 2016 at 7:00 pm

Interesting. That hasn't been my experience. I retire my tires when the tread is worn thin. With the old Grand Bois Hetre Extra Leger tires, there sometimes was fraying at the edge of the tread, because the transition between thick tread and thin sidewall created a stress riser. Our Compass tires have very thin tread at the edges to deal with this – plus it makes the tire more supple and lighter, too. (The tread at the edges doesn't wear, so you don't need any extra there.)

Blog at WordPress.com.